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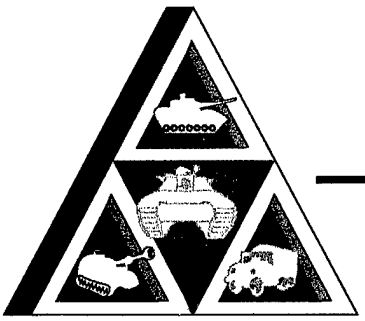

Technical Report

No. TR-13730

Field Demonstration For P-D-680 Solvent Replacement

October 1996

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13. ABSTRACT (Maximum 200 words)

As part of the second phase in development of environmentally compliant solvent alternatives to P-D-680, field demonstrations were initiated at Ft. Lewis WA, Ft. Hood TX, and Kelly Air Force Base. The main objectives of this demonstration were to validate performance of candidate solvents with existing military equipment and to determine the environmental applicability for these candidate solvents. Four (4) petroleum based solvents and four (4) terpene/hydrocarbon blended solvents have been selected as candidates for these field demonstrations. Ft. Lewis was designated as a major field testing site and evaluated eight (8) candidate solvents in various military ground equipment, helicopter, and weapon cleaning application. Ft. Hood evaluated two (2) different types of candidate solvents using the IT-48 weapons cleaning system in helicopter maintenance applications. San Antonio Air Logistic Center at Kelly AFB evaluated three (3) candidate solvents using existing part washers for aviation applications. Field test results showed that both severe hydrotreated odorless hydrocarbon solvents and hydrotreated terpene/hydrocarbon blended solvents were well accepted in all applications. Six candidate solvents were rated by users as acceptable replacements for P-D-680.

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P-D-680, Solvent, Alternative Solvents, Solvency, Field demonstration, Aviation, Ground equipment, Petroleum hydrocarbon, Terpene

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The author wishes to thank the all local testing coordinators and participating organizations who actually evaluated candidate solvents. Also, the author wishes to thank solvent industries who provided candidate solvents for these field demonstrations.

Contents

Section 1 Background

Department of Defense (DOD) facilities have been and continue to experience problems using P-D-680, Dry Cleaning and Degreasing Solvent[1], for their maintenance activities. Currently, numerous federal, state, and local regulations limit usage of P-D-680 as it is considered a hazardous waste, a flammable material, and a toxic substance[2]. To resolve this problem, the Fuels and Lubricants Technology Team of the Mobility Technology Center - Belvoir (MTC-B) as the specification Preparing Activity for P-D-680 has been working to develop environmentally compliant solvent alternatives that meet military requirements. This program, resourced under the Defense Supply Center Richmond's HAZMIN Program, was divided into the following two Phases.

Phase I: Conduct user survey for P-D-680 solvents and evaluate commercial alternative solvents

Phase II: Conduct field validation tests, and revise the P-D-680 specification

During 1994-1995, a P-D-680 user survey was completed to determine requirements and constraints for general purpose cleaning solvents to meet military needs. Based on the user survey, a new vision was established to resolve current P-D-680 problems and evaluate commercial candidate solvents as P-D-680 replacements. As a follow-up action, eighty - two (82) solvent samples were evaluated and comparisons made to P-D-680 solvents. It was found only petroleum distillate hydrocarbon solvents and terpene/hydrocarbon solvents met the current P-D-680 performance needs. Especially, terpene/hydrocarbon blended solvents gave excellent performance in all aspects of the laboratory testing requirements. Aqueous types of solvents and water based solvents were not applicable due to both their poor corrosion protection and solvency. Based on these test results, twenty-three (23) commercial solvents were selected as potential candidate alternative P-D-680 solvents. The test results were summarized in a TARDEC technical report[3] entitled "Replacement of P-D-680 Solvents for General Maintenance of DOD Equipment".

In concert with the Phase II portion of this initiatives, field demonstrations were initiated in 1996 at Army and Air Force installations to verify performance and environmental applicability of candidate solvents under a variety of field environments. Ft. Lewis WA was designated as a major field testing site for this demonstration and evaluated eight (8) candidate solvents in various military ground equipment (e.g., tactical vehicles), helicopter, and weapon cleaning applications. Ft. Hood evaluated two (2) different types of candidate solvents in helicopter maintenance applications.

For Air Force applications, San Antonio Air Logistic Center at Kelly AFB TX evaluated four (4) candidate solvents using aviation equipment and ground support equipment. The field demonstrations have been completed and data analyzed for each participating location.

This interim report summarizes the results of field demonstrations and findings.

Section 2 Field Demonstration Program

(a) Objective:

The main objectives of this field testing were (1) to verify performance (i.e., solvency, cleaning ability, compatibility) of candidate solvents in existing military equipment and, (2) to determine the environmental assessment for these candidate solvents (i.e., local/federal environmental laws, user safety). The successful completion of this demonstration would result the current P-D-680 solvents being replaced with environmentally friendly products.

(b) Scope:

The field demonstration encompassed three sites, Ft. Lewis WA, Ft. Hood TX and Kelly Air Force Base TX and focused on solvent cleaning performance and potential environmentally acceptability of candidate alternative P-D-680 solvents. Four (4) petroleum based solvents and four (4) terpene/hydrocarbon based solvents were finally selected as candidates for these cooperative field validation. The field validation of candidate solvents was performed using a wide variety of military equipment including weapon systems and measured by comparing their performance against provided by current P-D-680 solvents. The duration of this field test was designed for a three month evaluation period. The final acceptance of the candidate solvents would be based on the field testing evaluation and resultant findings generated.

(c) Field Testing Solvents:

The eight (8) solvents identified in Table 1 were selected from the twenty-three (23) candidate solvents recommended from Phase I. Three (3) petroleum based solvents were designated as P-D-680 Type II solvents and had different types of odor characteristics (i.e., odorless, milder, strong). An odorless petroleum based candidate solvent designated as a Type III was selected in order to make a comparison with the P-D-680 Type III solvent. Four (4) terpene/hydrocarbon blended solvents were also selected as a new proposed Type IV solvent under P-D-680. The laboratory test results are shown in Table 2 for these solvents along with the P-D-680 solvents. Also, the test methds used in this laboratory evaluation and the P-D-680 specification requirements are provided in Appendix A.

Table 1: Field Demonstration Solvents

Solvent	Designated P-D-680 Type	Odor Characteristics
Breakthrough	II	Odorless
Actrel 1171L	II	Strong hydrocarbon odor
Unocal 150	II	Mild hydrocarbon odor
134 Hi-Solv	III	Odorless
Skysol	IV*	Citrus
Skysol 100	IV	Citrus
Electron 296	IV	Citrus
PF	IV	Citrus

* Proposed new P-D-680 Solvent Type

(d) Field Testing Sites and Procedure:

Tables 3-5 summarize field testing sites and solvents that were evaluated at each installation as well as identifying the cleaning procedure used and equipment. All maintenance shops listed in these Tables currently use the P-D-680 Types I and II solvents in various types of part washers. To identify the field sites, special codes were used through this field demonstration; namely, FLT is Ft. Lewis, FHT is Ft. Hood, KAT is Kelly Air Force Base.

- Ft. Lewis, WA as previously stated was designated a major field testing site and evaluated all eight (8) candidate solvents in various military ground equipment (i.e., tactical vehicles) and helicopters in ten (10) different types of maintenance shops. Thirteen (13) IT-30 part washers procured by the Public Works Environmental and Natural Resources Division at Ft. Lewis were used in this solvent evaluation program. Additionally, three (3) candidate solvents designated as the proposed Type IV were evaluated at six (6) weapon cleaning stations.

- Ft. Hood, TX evaluated two (2) different types of candidate solvents using IT-48 weapons cleaning system (i.e, part washer) in helicopter application. Four (4) different maintenance shops participated in this field demonstration.

- San Antonio Air Logistic Center at Kelly AFB, TX evaluated four (4) candidate solvents using existing part washers in aviation applications.

(e) Schedule:

Milestone	Completion Date
Ft. Lewis equipment installation & testing set up and coordination	13-14 May 1996
Ft. Hood equipment installation & testing set up and coordination	20-21 May 1996
San Antonio Air Logistic Center (ALC) testing set up and coordination	22 May 1996
Field Test Initiation	1 June 1996
In Progress Review at Ft. Lewis	30 July 1996
In Progress Review at Ft. Hood	1 August 1996
In Progress Review at San Antonio ALC	2 August 1996
Field Test Completed	31 August 1996

(f) Data Collection:

All testing results and operator/user comments were recorded and tabulated using the attached Solvent Evaluation Sheet (Appendix B). Data have been reviewed and collected on a bi-weekly basis. The following performance characteristics were closely monitored at each testing site.

- The cleaning/soil removal performance of candidate solvents were compared to existing P-D-680 solvents (e.g., takes longer, requires more solvents, leave residue, does not remove soil, etc.)
- Any material incompatibility was identified (e.g., softens plastics, elastomers, etc).
- Corrosion protection characteristics were evaluated (e.g., evidence of pitting, rust, discoloration, etc).
- Drying time was noted (i.e., solvent remains or evaporates, air-blow required, etc).
- Environmental assessment were determined (i.e., health and safety factors, operator acceptability, odor, etc).

(g) Data Evaluation Score System:

To effectively evaluate field data, a score system was developed based on a typical university grading system. Maximum score was designated as 100 points and divided evenly between solvent performance and environmental assessment. The acceptance criteria for the candidate solvents was established at a rating of 80 points or higher using the following Data Evaluation Score System.

Solvent Performance	**50 points** (unacceptable to acceptable ranges)
• Solvent Cleaning Power (i.e., excellent=15 points, poor= 3 points)	3-15
• Compatibility (i.e., Yes=zero, No=10 points)	0 to 10
• Drying time (i.e., fast=5 points, slow=1 point)	1-5
• Corrosion (i.e., Yes=zero, No=10 points)	0 to 10
• Residue (i.e., Yes=zero, No=10 points)	0 to 10

Environmental Assessment	**50 points**
• Odor Characteristics (i.e., strong=5, milder=20, odorless=25)	5-25
• Toxicity (i.e., severe=5, less=20, no=25)	5-25

The degree of toxicity was measured based on worker skin irritation. It was divided into three categories and defined as follows;

No toxicity: Solvent does not adversely affect user's skin irritation without wearing rubber gloves

Less toxicity: Solvent does not adversely affect user's skin irritation with wearing rubber gloves.

Severe toxicity: Solvent does adversely affect user's skin irritation with wearing rubber gloves.

Overall Rating System

90 - 100	excellent
80 - 89	good
70- 79	average
0 - 69	poor

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Section 3 Test Results

A summary of the field test results and user's comments is presented in Tables 6-8. To analyze the data, each solvent was evaluated separately using the above described solvent cleaning performance and environmental assessment criteria, and the comments were converted to numerical system using the data evaluation score method. The final rating was derived based on the results of these field evaluations. The typical raw data sheets gathered from the field tests are provided in Appendix C. Data obtained for each candidate solvent were generated from three main military applications (i.e., ground equipment, aviation equipment, weapon system) at three different military installations. The cleaning methods used in this demonstration were the routine maintenance part cleaning procedures using IT-30/48 part washers and the other types of part washers such as a potable part cleaner. To validate the field data, most candidate solvents were tested at two different testing sites in each installation except for Kelly Air Force Base. Ft. Lewis evaluated eight (8) candidate solvents at eighteen (18) testing sites in three different applications; tactical vehicles, helicopters, small arms. Fort Hood also evaluated two (2) different types of candidate solvents at four (4) aviation maintenance shops. San Antonio Air Logistic Center at Kelly AFB assessed three (3) candidate solvents at two aviation repair shops. Representative photographs taken from the testing sites are provided in Appendix D.

For practical purposes, the field demonstration focused on solvency, drying time, compatibility, corrosion protection, residue, odor, and toxicity of candidate solvents. To draw the baseline of field performance, the P-D-680 Type II solvent was reevaluated concurrently. This solvent was originally formulated with petroleum distilled hydrocarbon and used for dry cleaning, spot, and stain removing, and for degreasing of component parts in maintenance activities. Most participants are currently using this solvent as a primary cleaning agent in their maintenance activity and have reported that P-D-680 Type II solvent to be an excellent degreaser with good corrosion protection properties, but has an offensive odor and some toxicity. Because of these environmental deficiencies, P-D-680 Type II was defined as environmentally unfriendly solvent and rated as a "poor solvent".

In ground equipment applications, three candidate solvents (Breakthrough, Unocal 150, Actrel 1171L) designated as Type II were tested in Ft Lewis tactical vehicle maintenance shops and compared with P-D-680. All three solvents were somewhat hydrotreated in order to reduce toxic aromatic materials such as benzene that provides a strong solvency. The test results showed although the new solvents provided somewhat weaker solvency than P-D-680, they demonstrated good cleaning ability in a wide variety of soils, especially heavily contaminated grease, hydraulic

fluid, engine oils, tar, carbon deposits and waxes. A candidate solvent (134 Hi-Solv) for Type III was also tested in tactical vehicle applications. Most users reported the performance of this solvent to be equivalent to the P-D-680 Type III. To determine suitability of terpene/hydrocarbon blended solvents in P-D-680 applications, three candidate solvents (Skysol 100, PF, Electron 296) were evaluated using tactical vehicle's parts such as wheel bearing, hydraulic fluid pump, engines, etc. These candidate solvents are actually hydrocarbon solvents containing small amounts of de-limon material (>15%) which used to enhance solvency. These candidate solvents were proposed as the to-be-established P-D-680 Type IV solvent. However, most users reported the solvency of the terpene/hydrocarbon blended solvents was the same as the other types of candidate hydrocarbon solvents. All solvents tested in ground equipment provided adequate solvent power which correlated with the laboratory evaluations. No corrosion, residue and compatibility problems were reported. Two hydrocarbon solvents (Unocal 150, Actrel 1171L) were rejected due to their strong hydrocarbon offensive odor which may affect worker's health. In general, the major sources of odor in petroleum hydrocarbon solvent are listed as aromatic content and the amount of impurities such as sulfur, peroxide, and nitrogen due to the wide distillation temperatures[4]. However, citron odor was not a problem in the ground vehicle cleaning applications.

In aviation applications, four (4) candidate solvents (Breakthrough, Skysol 100, Actrel 1171L, Electron 296) were tested at three military installations. The Ft. Lewis helicopter maintenance shop evaluated Skysol 100 solvent using helicopter parts such as engines, rotors, generators. etc.. This shop uses P-D-680 Type I which provides strong solvency and a fast drying time. Recently, EPA defined P-D-680 Type I solvent as a hazardous material due to its low flash point. For this reason, the Ft. Lewis aviation maintenance shop is currently seeking environmentally friendly solvents which can replace the P-D-680 Type I solvent. Most users reported the solvency of Skysol 100 solvent was adequate to clean soils contaminated in various types of aviation parts . No corrosion and compatibility problems were reported. Citron odor was not a major problem. However, some complaints related to slow drying time were received. Generally, Type II solvents provide slower drying time than Type I due to their higher flash points. This deficiency is minor and can be resolved using air dryers or ovens. Currently, Type II solvent is strongly recommended to replace the Type I as a means to reduce flammability problems. Ft. Hood also evaluated two candidate solvents (Skysol 100, Breakthrough) in helicopter applications such as engines, rotors, generators, etc.. Both solvents were very well accepted in all helicopter maintenance applications. Especially, most users indicated candidate solvents significantly reduce the toxicity (i.e., skin irritation) when compared to P-D-680. Drying time of candidate solvents was the same as for P-D-680 Type II. San

Antonio Logistic Center at Kelly AFB evaluated three candidate solvents (Breakthrough, Actrel 1171L, Electron 296)). In aviation fuel injection repair shop, Breakthrough solvent was very well accepted in comparison to the Actrel 1171L solvent due to its odorless characteristics. Electron 296 solvent was also well accepted by aviation ground supporting equipments such as electric generators. No d-limon odor problem was reported. All candidate hydrocarbon and terpene/ hydrocarbon blended solvents were well accepted by aviation users except for the Actrel 1171L solvent. Also, it was observed that d-limon odor was viewed as favorable in open maintenance shops, but a strong offensive hydrocarbon solvent odor was found to be a major problem in all working areas.

P-D-680 solvents are also widely used in weapon cleaning applications. Due to the environmental regulations, this application currently demands a new environmentally acceptable solvent to remove oils, greases, and carbon residue deposited after firing. To determine usability of candidate solvents in weapon applications, Ft. Lewis evaluated three solvents (Breakthrough, Skysol, Skysol 100) using small arms such as the M16 rifle. These candidate solvents were formulated based on the same type of petroleum based hydrocarbon with various amounts of d-limon content and were designed as general solvent cleaners. Breakthrough solvent does not contain any d-limon material, while Skysol solvent has 5 % of d-limon content. However, the Skysol 100 solvent contains 10 % of d-limon material in order to increase its solvency. All these products are non-carcinogenic and do not contain any ingredients listed by EPCRA, CERCLA, and RCRA. Also, worker exposure is not regulated by OSHA. The test results showed the performance of all candidate solvents was acceptable except for their odor characteristics. Also, it was found all three solvents provided similar solvency in these weapon cleaning applications. Few users reported both Skysol and Skysol 100 solvents tends to occasionally leave slight residues on cleaned parts due to the impurity of d-limon. This problem was not observed at Ft. Hood. Also, Ft. Hood did not find any abnormal behavior of Skysol 100 solvent, and accepted this as a replacement for P-D-680. In these demonstrations, a strong citron odor was a major problem in closed areas of weapon cleaning facilities. Generally, the large variations of odor depend on human sensitivity and are very difficult to control in small closed areas. Odorless products such as Breakthrough solvent were well accepted in both open and closed weapon cleaning facilities.

To reduce waste stream, solvent recycling is common practice in many industries (i.e., Safety Kleen Company) and a wide range of solvents are currently recycled using several different types of distillation techniques. During P-D-680 user survey conducted in Phase I within DOD, most military users expressed their concerns to the current disposal problems of P-D-680 solvents. Although a solvent recycling

demonstration was not conducted in this study, most users observed the recirculation part washers actually served as a recycling unit and significantly extended solvent useful life. It appears this system can reduce solvent waste stream and is a first step to resolve the environmental problems the military currently faces.

Section 4 Conclusions

On the basis of the work completed to date, field demonstrations were successively completed at Army and Air Force installations. The following finding evolved during the field demonstrations.

- Severe hydrotreated odorless hydrocarbon solvents were very well accepted because of their low odor characteristics and less toxicity. Especially, the candidate Type II product is more favored than the Type III due to its faster drying time.
- Hydrotreated terpene/hydrocarbon blended solvents were also very well accepted in all applications. Citron odor was not considered as a major problem in open working areas.
- Odor, cleaning power, corrosion protection and toxicity of solvent were major evaluation selection factors for all cleaning applications.
- Most users did not like to continuously use hydrocarbon solvents having strong offensive odors (i.e., the P-D-680 Types I and II odor).
- Odorless hydrotreated Type II hydrocarbon solvent was acceptable for weapon cleaning applications due to its odorless characteristics.
- All candidate solvents performed well for all applications when compared to P-D-680 solvents which have a strong hydrocarbon odor and medium level of toxicity (i.e., irritation to skin).
- Candidate Type II solvents were found to be acceptable when used in applications requiring Type I.
- Laboratory test results correlated well with field performance.
- The following six candidate solvents were rated by users as acceptable replacements for P-D-680.

Type	Solvent Composition	Candidate P-D-680 Solvent
I	Hydrocarbon	Type II solvent
II	Hydrocarbon	Breakthrough
III	Hydrocarbon	134 Hi-Solv
IV*	Terpene/Hydrocarbon Blend	Skysol Skysol 100 Electron PF

*This is a proposed new Type for P-D-680 and its performance is equivalent to Type II.

Because of the wide application of P-D-680 solvents within DOD, this field demonstration is being extended to validate the performance of the above candidate environmentally complaint solvents for Naval shipboard applications.

References

1. Federal Specification P-D-680, Dry Cleaning and Degreasing Solvent, 29 October, 1992.

2. Connie Van Brocklin, "Replacement of P-D-680 for Army Ground Vehicle and equipment Applications", Letter Report 94-1, October, 1993.

3. In-Sik Rhee, Carlos Venez., Karen Von Bernewitz, "Replacement of P-D-680 Solvents for General Maintenance of DOD Equipment", TARDEC Technical Report No. 13643, September, 1995.

4. Correspondence from Inland Technology Company, 19 August, 1996.

Table 2. Laboratory Solvent Test Results

Product Code	Flash Point, °C	Distillation, °C		Kauri-Butanol value	Non-volatile residue, %	Aniline Point, °C	Odor	VOC g/l	Evap %, @ 20 min.	Corrosion		Relative Solvency, %
		I.B.P	D.P							Cu	Fe	
P-D-680 (I)	47.0	165.4	204.6	39	0.1	61.2	strong	789.7	47.1	1a	no rust	94.7
P-D-680 (II)	63.0	182.8	206.7	32	0.07	73.1	strong	785.8	22.8	1a	no rust	94.4
P-D-680 (III)	93.3	223.4	269.0	31	0.3	76.1	odorless	823.2	4.6	1a	no rust	89.3
Breakthrough	65.5	184.0	211.7	27	0.05	84.0	odorless	770	25.9	1b	no rust	87.6
Actrel 1171L	81.1	211.6	241.1	30	0.35	77.8	strong	797	10.1	1a	no rust	84.5
Unocal 150	66.7	186.0	212.7	31	0.15	71.2	mild	772	19.1	1b	no rust	90.2
134 Hi-Solv	97.8	232.4	299.3	24	0.07	94.5	odorless	796	3.8	1b	no rust	80.7
Skysol	66.7	189.4	212.4	29	0.16	83.0	citrus	770	20.0	1b	no rust	89.1
Skysol 100	63.3	189.6	212.7	29	0.44	82.8	citrus	780	25.3	1a	no rust	88.6
Electron 296	63.9	191.8	235.6	32	0.01	69.1	citrus	782	18.1	1b	no rust	87.8
PF	62.2	187.0	228.8	26	0.32	76.7	citrus	760	14.8	1b	no rust	92.3

Table 3. Field Testing Sites for P-D-680 Replacement Solvent at Fort Lewis

Field Testing Site	Location	Candidate Solvent	Designated Type to P-D-680	Military Equipment	Cleaning Method	Specified Cleaning Solvent
FLT-1	Bldg: 9580 Unit: 296th DS+/DOL Maintenance Shop POC: Chief Richardson Tel: 967-6915	Breakthrough (Hydrocarbon)	II	M-1 Tank Engine Parts, Track Vehicle Parts	Remove grease/oil using hand cleaning procedure and IT-30 parts washer with edgeteck filter system	P-D-680 Type II supplied by Safety Kleen Company
FLT-2	Bldg: 3750 Unit: 296th, B Co. DS Maintenance Shop POC: Chief Richardson Tel: 967-6915	134 Hi-Solv (Hydrocarbon)	III	Track and Wheeled Vehicles, M998 series, M113 series, M994 series, M931 series, etc.	Remove grease/oil using hand cleaning procedure and IT-30 parts washer with edgeteck filter system	P-D-680 Type II supplied by Safety Kleen Company
FLT-3	Bldg: 3960 Unit: 542nd MT DS Maintenance Shop POC: Chief Jones Tel: 967-6667	Actrel 1171L (Hydrocarbon)	II	Wheeled Vehicles, Automotive Rolling Stock, Hydraulic system, Transmission system	Remove grease/oil using hand cleaning procedure and IT-30 parts washer with edgeteck filter system	P-D-680 Type II supplied by Safety Kleen Company
		Electron 296 (Terpene/Hydrocarbon blend)	IV*			
FLT-4	Bldg: 3945 Unit: 1-37 FA DS Maintenance Shop POC: MSG Carney Tel: 967-6653	Unocal 150 (Hydrocarbon)	II	Track and Wheeled Vehicles;. Wheel bearings, Hydraulic system, Engine, transmission, Fuel system , Mechanical parts, etc.	Remove grease/oil using hand cleaning procedure and IT-30 parts washer with edgeteck filter system	P-D-680 Type II supplied by Safety Kleen Company
		Electron 296 (Terpene/Hydrocarbon Blend)	IV			

Field Testing Site	Location	Candidate Solvent	Designated Type to P-D-680	Military Equipment	Cleaning Method	Specified Cleaning Solvent
FLT-5	Bldg: 3943 Unit: I-37 A/B Battery Maintenance Shop POC:MSG Carney Tel: 967-6653	PF (Terpene/Hydro carbon Blend)	IV	Track Vehicles; wheel bearing, accessory, mechanical parts, power train system, engine components, etc.	Remove grease/oil using hand cleaning procedure and IT- 30 parts washer with edgeteck filter system	P-D-680 Type II supplied by Safety Kleen Company
FLT-6	Bldg: 3941 Unit: 1-37 FA Vehicle maintenance shop POC: MSG Carney Tel: 967-6653	Breakthrough	II	Track Vehicles; Wheel bearings, Mechanical parts, Hydraulic system, Transmission, etc.	Remove grease/oil using hand cleaning procedure and IT- 30 parts washer with edgeteck filter system	P-D-680 Type II supplied by Safety Kleen Company
FLT-7	Bldg: 3957 Unit: 542nd MT Maintenance Shop POC: Chief Jones Tel: 967-6667	Acetrel 1171L	II	Engineering Equipment, Power Generation Equipment, Hydraulic control valve, Spool valve, etc.	Remove grease/oil using hand cleaning procedure and IT- 30 parts washer with edgeteck filter system	P-D-680 Type II supplied by Safety Kleen Company
FLT-8	Bldg: 2071 Unit: 63rd ORD Vehicle maintenance shop POC: Chief Fields Tel: 967-6889	Skysol 100 (Terpene/Hydro carbon Blend)	IV	Engineering Equipment, Wheel vehicles; M998, M1074, M939, ATFL 6K, 40T Crane, etc.	Remove grease/oil using hand cleaning procedure and IT- 30 parts washer with edgeteck filter system	P-D-680 Type II supplied by Safety Kleen Company
FLT-9	Bldg: 2057 Unit: 528th QM Maintenance Shop POC: Chief Wycoff Tel: 967-5653	Unocal 150 (Hydrocarbon)	II	Wheeled vehicles; M939 series, M998, M916, M35A2, DF7 Dozer, M10A Forklift, 350 GPM Pumps, etc.	Remove grease/oil using hand cleaning procedure and IT- 30 parts washer with edgeteck filter system	P-D-680 Type II supplied by Safety Kleen Company
FLT-10	Bldg: 2059 Unit: 497th TRAN Maintenance Shop POC: Chief Vicent Tel: 967-5404	134 Hi-Solv	III	Large wheeled vehicles; M923, M998, M931, A-1, A-2, etc.	Remove grease/oil using hand cleaning procedure and IT- 30 parts washer with edgeteck filter system	P-D-680 Type II supplied by Safety Kleen Company

Field Testing Site	Location	Candidate Solvent	Designated Type to P-D-680	Military Equipment	Cleaning Method	Specified Cleaning Solvent
FLT-11	Bldg: 9160 Unit: Ist SFG, S-4 SEV DET POC: SGT Haddow-Green Tel: 967-8735	Skysol 100 (Terpene/Hydro carbon Blend)	IV	M2, M16 Rifle, M-60, Small Arms	Remove grease/oil/carbon deposit using hand cleaning procedure and IT-48 weapon cleaning system with edgeteck filter system	P-D-680 Type II supplied by Safety Kleen Company
FLT-12	Bldg: 9181 Unit: Ist SFG, GSC POC:Ssgt Hareld Tel: 967-8916	Skysol 100 (Terpene/Hydro carbon Blend)	IV	M2, M16 Rifle, M-60, Small Arms	Remove grease/oil/carbon deposit using hand cleaning procedure and IT-48 weapon cleaning system with edgeteck filter system	P-D-680 Type II supplied by Safety Kleen Company
FLT-13	Bldg: 9162 Unit: Ist SFG, 3rd BN POC:Sfc Lance Tel: 967-8811	Skysol 100 (Terpene/Hydro carbon Blend)	IV	M2, M16 Rifle, M-60, Small Arms	Remove grease/oil/carbon deposit using hand cleaning procedure and IT-48 weapon cleaning system with edgeteck filter system	P-D-680 Type II supplied by Safety Kleen Company
FLT-14	Bldg: 3280 Unit: 2-8 FA POC:Cpl Swinton Tel: 967-1858	Skysol 100 (Terpene/Hydro carbon Blend)	IV	M2, M16 Rifle, M-60, Small Arms	Remove grease/oil/carbon deposit using hand cleaning procedure and IT-48 weapon cleaning system with edgeteck filter system	P-D-680 Type II supplied by Safety Kleen Company

Field Testing Site	Location	Candidate Solvent	Designated Type to P-D-680	Military Equipment	Cleaning Method	Specified Cleaning Solvent
FLT-15	Bldg: 3766D Unit: 1-23 Inf, 3rd BCT POC:Sgt Gonzales Tel: 967-9167	Breakthrough (Hydrocarbon)	II	M2, M16 Rifle, M-60, Small Arms	Remove grease/oil/carbon deposit using hand cleaning procedure and IT-48 weapon cleaning system with edgeteck filter system	P-D-680 Type II supplied by Safety Kleen Company
FLT-16	Bldg: North Fort ROTC Unit: ROTC POC:Alice Murrell Tel: 967-4202 Cleaning Station : 2	Skysol** (Terpene/Hydro carbon Blend)	IV	M2, M16 Rifle, M-60, Small Arms	Remove grease/oil/carbon deposit using hand cleaning procedure and IT-48 weapon cleaning system with edgeteck filter system	P-D-680 Type II supplied by Safety Kleen Company
		Breakthrough (Hydrocarbon)	II			
FLT-17	Bldg: 3098 Unit: ATCOM OLR POC:Tom Maniglia Tel: 967-2409	Skysol 100 (Terpene/Hydro carbon blend)	IV	Aircraft/Parts, CH-47, UH-60, OH-58, AH-1, etc.	Remove grease/oil using hand cleaning procedure and IT- 30 parts washer with edgeteck filter system	P-D-680 Type I supplied by Safety Kleen Company
FLT-18	Bldg: 3390 Unit: 864th ENG BN, HHC POC:2nd Lt Warder Tel: 967-5873	PF (Terpene/Hydro carbon Blend)	IV	Engineering Equipment; M998, M1074, M939, M916, ATFL 6K, 40T Cranes.	Remove grease/oil using hand cleaning procedure and IT- 30 parts washer with edgeteck filter system	P-D-680 Type II supplied by Safety Kleen Company

* Proposed P-D-680 Type ** Substitute solvent for only weapon cleaning application

Table 4. Field Testing Sites for P-D-680 Replacement Solvent at Fort Hood

Field Testing Site	Location	Candidate Solvent	Designated Type to P-D-680	Military Equipment	Cleaning Method	Specified Cleaning Solvent
FHT-1	Bldg: 6970 Unit: Helicopter Engine Repair Shop POC: Mr. McKenize Tel: 288-3252	Breakthrough (Hydrocarbon)	II	All types of helicopter engines; AH-64A Apache, Black Hawk, CH-47, MH-47E, MH-60K, Quick Fix, OH-58, etc.	Remove grease/oil using hand cleaning procedure and IT- 48 weapon cleaning system with edgeteck filter system	P-D-680 Type II supplied by DSCR
FHT-2	Bldg: 7012 Unit: Helicopter Propeller Rotor Repair Shop POC: Mr. Stinson Tel: 287-2539	Skysol 100 (Terpene/Hydrocarbon Blend)	IV*	All types of helicopter propeller rotors; AH-64A Apache, Black Hawk, CH-47, MH-47E, MH-60K, Quick Fix, OH-58, etc.	Remove grease/oil using hand cleaning procedure and IT- 48 weapon cleaning system with edgeteck filter system	P-D-680 Type II supplied by DSCR
FHT-3	Bldg: 6975 Unit: Aviation Maintenance Service Branch POC: Mr. Bayness Tel: 288-3510	Skysol 100 (Terpene/Hydrocarbon Blend)	IV	Helicopter weapon system , small arms; 30mm Caliber	Remove grease/oil/carbon deposit using hand cleaning procedure and IT- 48 weapon cleaning system with edgeteck filter system	P-D-680 Type II supplied by DSCR
FHT-4	Bldg: 739 Unit: Helicopter Generator Repair Shop POC: Mr. Chuk Tel: 288-3560	Breakthrough (Hydrocarbon)	II	Helicopter electric generator parts	Remove grease/oil/carbon deposit using hand cleaning procedure and IT- 48 weapon cleaning system with edgeteck filter system	P-D-680 Type II supplied by DSCR

* Proposed P-D-680 Type

Table 5. Field Testing Sites for P-D-680 Replacement Solvent at Kelly Air Force Base

Field Testing Site	Location	Candidate Solvent	Designated Type to P-D-680	Military Equipment	Cleaning Method	Specified Cleaning Solvent
KAT-1	Bldg: 348 Unit: Aviation Fuel Accessories Repair Shop POC: Mr. Huron Tel: 210-925-7554	Breakthrough (Hydrocarbon)	II	All types of aircraft fuel control system; F15, F16, C58, C130, C131, etc.	Remove grease/oil/carbon deposit using hand cleaning procedure and two bench types of cleaner and one spray gun part washer. All these part washers are recirculated system.	P-D-680 Type II supplied by DSCR
		Actrel 1171L (Hydrocarbon)	II			
		Skysol 100 (Terpene/Hydrocarbon Blend)	IV*			
KAT-2	Bldg: 894 Unit: 433rd AGE Shop POC: Jim Barajas Tel: 210-977-4098	Electron 296 (Terpene/Hydrocarbon Blend)	IV	Aerospace ground supporting equipment	Remove grease/oil/ using part washers	P-D-680 Type II supplied by DSCR

* Proposed P-D-680 Type

Table 6. Field Test Results from Fort Lewis

Field Testing Site	Candidate Solvent	Total Response	Military Equipment	Comments	CPP[1]	EAP[2]	Total Point	Ranking
FLT-1	Breakthrough (Hydrocarbon)	21	M-1 Tank Engine Parts, Track Vehicle Parts	. No residue problem . Strong solvency . No odor . Less toxic than P-D-680 . Acceptable solvent	40	45	85	Good
FLT-2	134 Hi-Solv (Hydrocarbon)	3	Track and Wheeled Vehicles, M998 series, M113 series, M994 series, M931 series, etc.	. Slow drying time . No odor . No residue problem . Good solvency . Useful solvent	45	43	88	Good
FLT-3	Actrel 1171L (Hydrocarbon)	18	Wheeled Vehicles, Automotive Rolling Stock, Hydraulic system, Transmission system	. Very strong solvent . No residue problem . Strong hydrocarbon odor . Same as P-D-680 . Not favorite	39	33	72	Average
	Electron 296 (Terpene/Hydrocarbon blend)	19		. Acceptable citron odor . Strong solvency . No residue problem . Less toxic than P-D-680 . No corrosion . No compatibility problem . Normal drying time . Acceptable solvent	45	40	85	Good

Field Testing Site	Candidate Solvent	Total Response	Military Equipment	Comments	CPP[1]	EAP[2]	Total Point	Ranking
FLT-4	Unocal 150 (Hydrocarbon)	5	Track and Wheeled Vehicles;. Wheel bearings, Hydraulic system, Engine, transmission, Fuel system , Mechanical parts, etc.	. Very strong solvent . Strong hydrocarbon odor . Fast drying . No residue problem . Good performance . Same as P-D-680	45	25	70	Average
	Electron 296 (Terpene/Hydr ocarbon Blend)	15		. Less odor . Milder solvent . Good performance . Less toxic than P-D-680 . No residue problem . Acceptable solvent	43	42	85	Good
FLT-5	PF (Terpene/Hydr ocarbon Blend)	8	Track Vehicles; wheel bearing, accessory, mechanical parts, power train system, engine components, etc.	. Citron odor . Milder solvent . Good performance . Less toxic than P-D-680 . No residue problem . Acceptable solvent	45	40	85	Good
FLT-6	Breakthrough	25	Track Vehicles; Wheel bearings, Mechanical parts, Hydraulic system, Transmission, etc.	. No odor . Good cleaning power . No residue problem . No corrosion . Fast drying time . No irritation to skin . Acceptable solvent	44	44	88	Good
FLT-7	Acetrel 1171L (Hydrocarbon)	9	Engineering Equipment, Power Generation Equipment, Hydraulic control valve, Spool valve, etc.	. Strong hydrocarbon odor . Strong solvency . Same as P-D-680 . Not favorable	41	25	66	Poor

Field Testing Site	Candidate Solvent	Total Response	Military Equipment	Comments	CPP[1]	EAP[2]	Total Point	Ranking
FLT-8	Skysol 100 (Terpene/Hydrocarbon Blend)	17	Engineering Equipment, Wheeled vehicles; M998, M1074, M939, ATFL 6K, 40T Crane, etc.	. Citron odor . Milder solvent . Good cleaner . No irritation to skin . Fast drying time . No corrosion . Acceptable solvent	42	40	82	Good
FLT-9	Unocal 150 (Hydrocarbon)	16	Wheeled vehicles; M939 series, M998, M916, M35A2, DF7 Dozer, M10A Forklift, 350 GPM Pumps, etc.	. Strong solvent power . Strong hydrocarbon odor . Same as P-D-680	46	25	71	Average
FLT-10	134 Hi-Solv	4	Large wheeled vehicles; M923, M998, M931, A-1, A-2, etc.	. Less odor . Slow drying time . Medium cleaning power . No irritation to skin . No corrosion	40	43	83	Good
FLT-11	Skysol 100 (Terpene/Hydrocarbon Blend)	19	M2, M16 Rifle, M-60, Small Arms	. Citron odor . Strong cleaning power . Less toxic than P-D-680 . Good carbon remover . No corrosion . Acceptable solvent	44	38	82	Good
FLT-12	Skysol 100 (Terpene/Hydrocarbon Blend)	13	M2, M16 Rifle, M-60, Small Arms	. Strong citron odor in office space . Good performance over 2,000 weapon cleaning application . Less toxic than P-D-680 . No corrosion . Acceptable solvent	43	35	78	Average

Field Testing Site	Candidate Solvent	Total Response	Military Equipment	Comments	CPP[1]	EAP[2]	Total Point	Ranking
FLT-13	Skysol 100 (Terpene/Hydrocarbon Blend)	4	M2, M16 Rifle, M-60, Small Arms	. Citron odor . Good cleaning power . Safe solvent . Acceptable solvent	48	36	84	Good
FLT-14	Skysol 100 (Terpene/Hydrocarbon Blend)	Interview	M2, M16 Rifle, M-60, Small Arms	. Citron odor . Milder solvent . Good performance . Acceptable solvent	42	40	82	Good
FLT-15	Breakthrough (Hydrocarbon)	57	M2, M16 Rifle, M-60, Small Arms	. No odor . No corrosion . Good performance . Slight residue problem . Drying time same as P-D-680 Type II . Acceptable solvent in small office space	43	42	85	Good
FLT-16	Skysol (Terpene/Hydrocarbon Blend)	425	M2, M16 Rifle, M60, Small Arms	. Less citron odor . Good solvency . Slight residue problem . Same as Breakthrough solvent . Acceptable solvent	43	41	84	Good
	Breakthrough (Hydrocarbon)	72		. No odor . Good solvency . Less toxic than P-D-680 . No residue . No corrosion . No compatibility problem . Acceptable solvent	40	45	85	Good

Field Testing Site	Candidate Solvent	Total Response	Military Equipment	Comments	CPP[1]	EAP[2]	Total Point	Ranking
FLT-17	Skysol 100	25	Aircraft/Parts, CH-47, UH-60, OH-58, AH-1	. No odor problem . Good cleaner . No corrosion . Slow drying time . Acceptable solvent	40	40	80	Good
FLT-18	PF	7	Engineering Equipment, Wheeled vehicles; M998, M1074, M939, M916, ATFL 6K, 40T Cranes	. Citrus odor . Good solvency . Normal drying time . No corrosion . No residue . No compatibility problem . Less toxic than P-D-680 . Acceptable solvent	45	44	89	Good

1. Cleaning Performance Point 2. Environmental Assessment Point

Table 7. Field Test Results from Fort Hood

Field Testing Site	Candidate Solvent	Total Response[1]	Military Equipment	Comments	CPP[2]	EAP[3]	Total Point	Ranking
FHT-1	Breakthrough (Hydrocarbon)	2	All types of helicopter engines; AH-64A Apache, Black Hawk, CH-47, MH-47E, MH-60K, Quick Fix, OH-58, etc.	. No odor . Solvency is same as P-D-680 . No corrosion . No residue . Less toxic than P-D-680 . Good performance . Acceptable solvent	45	45	90	Excellent
FHT-2	Skysol 100 (Terpene/Hydrocarbon Blend)	2	All types of helicopter propeller rotors; AH-64A Apache, Black Hawk, CH-47, MH-47E, MH-60K, Quick Fix, OH-58, etc.	. Citron odor (better than P-D-680 odor) . Slow evaporation . Good performance . No irritation to skin . No residue . Acceptable solvent	47	40	87	Good
FHT-3	Skysol 100 (Terpene/Hydrocarbon Blend)	2	Helicopter weapon system , small arms; 30mm Caliber	. No odor problem . Good cleaning power . No irritation to skin . No corrosion . Acceptable solvent	48	40	88	Good
FHT-4	Breakthrough (Hydrocarbon)	2	Helicopter electric generator and starter parts	. No odor . Milder solvent . No corrosion . No irritation to skin . Acceptable solvent		45	93	Excellent

1. Semi-overall report 2. Cleaning Performance Points 3. Environmental Assessment Points

Table 8. Field Test Results from Kelly Air Force Base

Field Testing Site	Candidate Solvent	Total Response	Military Equipment	Comments	CPP[1]	EAP[2]	Total Point	Ranking
KAT-1	Breakthrough (Hydrocarbon)	6	All types of aircraft fuel control system; F15, F16, C58, C130, C131, etc.	. No odor . Excellent cleaning power . No corrosion . No residue . Fast drying time . No compatibility problem . Acceptable solvent	48	45	93	Excellent
	Actrel 1171L (Hydrocarbon)	3		. Strong odor same as P-D-680 . Poor solvency . Slow evaporation . No corrosion . No residue . No compatibility problem . No irritation to skin . Not acceptable solvent	35	30	65	Poor
	Skysol 100 (Terpene/Hydrocarbon Blend)	None		. No data	-	-	-	-
KAT-2	Electron 296 (Terpene/Hydrocarbon Blend)	5	Aerospace ground supporting equipment	. Excellent solvency . Fast evaporation than P-D-680 . No residue . No corrosion . No compatibility problem . No irritation to skin . Very pleasant odor . Acceptable solvent	46	40	86	Good

1. Cleaning Performance Point 2. Environmental Assessment Point

Appendices

Appendix A-1. Test Protocol for Alternative P-D-680 Solvents

Test	Method
Flash point	ASTM D 56
Distillation	ASTM D 86
Kauri-Butanol value	ASTM D 1133
Aniline point	ASTM D 611
Odor	ASTM D 1298
Non-volatile residue	TGA*
Evaporation @ 50 °C, 20 min	TGA
Copper corrosion	ASTM D 130
Steel corrosion	Modified ASTM D 130
VOC content	EPA method 24
Relative solvency	Army soil test method

* Thermogravimetric Analysis

Appendix A-2. P-D-680 Specification Requirements

Characteristics	Type I	Type II	Type III
Flash point, °C, min	38.0 (100 °F)	60.0 (140 °F)	93.3 (200 °F)
Distillation, °C:			
Initial boiling pt., min	149	177	220
50 % recovered	Report	Report	Report
Dry point, °C, max	208	211	295
Aniline point, °C	57 to 74	57 to 74	73 to 89
Kauri-butanol value	20 to 45	29 to 45	27 to 45
Allowable constituents, (% by volume): 1/			
(a) Solvent with olefinic or cyclo-olefinic	5	5	0.8
(b) Aromatic compounds with eight or more carbon atoms, except ethylbenzene, max	8	8	0.8
(c) Total of ethylbenzene, toluene, and branched chain ketones, max	20	20	1
(d) Total 0f (a) + (b) + (c), max	20	20	1
Total chlorine content (ppm) max	100	100	100
Apparent specific Garvity	0.754 to 0.820	0.754 to 0.820	0.740 to 0.840
Non-volatile residue (mg/100 mL), max	10	10	10
Color, min	25	25	30
Odor 2/	Characteristic & non-residual	Characteristic & non-residual	Low & non-residual
Corrosion, copper, max 3/	2A	2A	2A
Acidity	neutral	neutral	neutral
Doctor test	negative	negative	negative
Vapor pressure, Torr @ 20 °C, max	-	-	0.40
Total phenol content (ppm), max	0.5	0.5	0.5
Viscosity, cSt at 25 °C, max	-	-	5.0

1/ These maximum limits are as defined in rule 102, South Coast Air Quality Management District regulations

Appendix B. Solvent Evaluation Sheet

Solvent Evaluation Sheet for P-D-680 Replacements

1. User Category

What class of material is cleaned by P-D-680 solvents?
(e.g., weapons, artillery, armored, tactical vehicles, combat services support, aircrafts, ships, bearings, etc...)

What is your organization and installation?

Please provide your name, title, address and phone number:

2. Evaluation of Current P-D-Solvents

What types of P-D-680 solvents are you currently using to clean weapons, vehicles, or other equipment? (e.g., types 1, 2, 3)

Are you currently using other than P-D-680 solvents?

What problems have you experienced with current P-D-680 solvents?

What do you like about current P-D-680 solvents?

What don't you like about current P-D-680 solvents?

What type of P-D-680 solvents do you like that fit your applications?

3. Evaluating Alternative P-D-680 Solvents

Name of solvent:

What type of cleaning method(s) did you use to evaluate this solvent? (short description)

What types of equipment or parts were used to evaluate this solvent?

What is your opinion on the solvency (i.e., cleaning characteristics) of this solvent? (e.g., excellent, good, average, poor)

What is your rating as to its drying time or how quickly did it evaporate? (e.g., fast, normal, slow)?

Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent? (e.g., pitting, rust,...etc.)

Did you observe any in compatibility problem between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed,...etc.)

Did you smell any odor? If so, describe what type of odor and the degree of odor. (e.g., strong, mild, odorless, ...etc.)

When compared this solvent with P-D-680, which productis better fitted for your applications?

Overall, what rating would you give for this solvent? (accept, or reject)

4. Health, Safety of Alternative P-D-680 Solvent

Have you, or did you have knowledge of others that may have experienced nausea, skin rashed, or other adverse effects from use of this alternative P-D-680 solvent? Discuss.

Did you have problems in disposing of this alternative P-D-680 solvent that you tested?

Did you see any possible flammability problems with using this solvent?

5. **Speak Out!**

   Please discuss anything else pertaining to tested solvent that you would like to voice, especially comments and suggestions for the development of an improved cleaning product?

6. **This solvent evaluation sheet should be returned as soon as possible after completion of field test:**

   Department of the Army
   Mobility Technology Center - Belvoir
   Attn AMSTA RBF (MR I RHEE)
   10115 Gridely Rd STE 128
   Fort Belvoir, VA 22060-5843

   Questions may be directed to:

   Mr. In-Sik Rhee Fuels and Lubricants technology Team
   Telephone: (703) 704-1824 or DSN 654-1824
   Fax : (703) 704-1822

Appendix C-1. Typical field Data obtained from Fort Lewis, WA

a. Ground Equipment Application

b. Weapon Cleaning Application

c. Aviation Application

a. Ground Equipment Application

- Breakthrough
- 134 Hi-Solv
- Actrel 1171L
- Electron 296
- PF
- Skysol 100
- Unocal 150

SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS

TANK ID: ST-012

Date: 9/3/96

Name: LEWIS

Type of Part Cleaned (e.g. wheel bearings): OIL TANK, engine Lines

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

5 (4) 3 2 1

Heavily soiled.....moderately soiled.....lightly soiled

2. What type of media did you remove from the part? (Circle all that apply)

(Grease) (Oil) (Dirt) (Mud) Other (Describe) _____

3. Please rate the solvency (cleaning characteristics) of this solvent?

5 4 (3) 2 1

excellent.....good.....average.....poor

Remarks (If any): _____

4. What is your rating as to its drying time or how quickly did it evaporate?

5 4 (3) 2 1

fast.....normal.....slow

5. Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent?

YES (NO)

If yes, please explain what kind (e.g. pitting, rust, etc.):_____

6. Did you observe any incompatibility problems between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed,....etc.)

YES (NO)

If yes, please explain and list the particular part cleaned:_____

7. Did you observe any residue on the part after using this solvent?

YES (NO)

8. Did you smell any odor?

YES (NO)

If yes, explain what type of odor and the degree of odor. (e.g., strong, mild, odorless, ...etc.)

9. Did you see any possible flammability problems with using this solvent?

YES (NO)

10. Rate this solvent's acceptability for cleaning your part?

5 4 (3) 2 1

Highly acceptable.....Acceptable.....Reject

REMARKS:

134 Hi-Solv

SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS

TANK ID: ST-011

Date: 2-24-96
Name: SFC Headrick

Type of Part Cleaned (e.g. wheel bearings): Engine Assembly

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

(5) 4 3 2 1
Heavily soiled.....moderately soiled.....lightly soiled

2. What type of media did you remove from the part? (Circle all that apply)

(Grease) (Oil) (Dirt) Mud Other (Describe) _____

3. Please rate the solvency (cleaning characteristics) of this solvent?

5 4 (3) 2 1
excellent.....good.....average.....poor

Remarks (If any): _____

4. What is your rating as to its drying time or how quickly did it evaporate?

5 4 (3) 2 1
fast.....normal.....slow

5. Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent?

YES (NO)

If yes, please explain what kind (e.g. pitting, rust, etc.): _____

6. Did you observe any incompatibility problems between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed,....etc.)

YES (NO)

If yes, please explain and list the particular part cleaned: _____

7. Did you observe any residue on the part after using this solvent?

YES (NO)

8. Did you smell any odor?

YES (NO)

If yes, explain what type of odor and the degree of odor. (e.g., strong, mild, odorless, ...etc.)

9. Did you see any possible flammability problems with using this solvent?

YES (NO)

10. Rate this solvent's acceptability for cleaning your part?

5 (4) 3 2 1
Highly acceptable.....Acceptable.....Reject

REMARKS:

Actrel 1171L

SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS

TANK ID: ST-008

Date: 3 Jun 96

Name: Robert Harper

Type of Part Cleaned (e.g. wheel bearings): Oily bucket

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

5 Heavily soiled ..... 4 ..... 3 ..... (2) moderately soiled ..... 1 lightly soiled

2. What type of media did you remove from the part? (Circle all that apply)

Grease (Oil) Dirt Mud Other (Describe) _____

3. Please rate the solvency (cleaning characteristics) of this solvent?

5 excellent ..... 4 ..... (3) good ..... 2 ..... average ..... 1 poor

Remarks (If any): _____

4. What is your rating as to its drying time or how quickly did it evaporate?

5 fast ..... 4 ..... (3) normal ..... 2 ..... 1 slow

5. Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent?

YES (NO)

If yes, please explain what kind (e.g. pitting, rust, etc.): _____

6. Did you observe any incompatibility problems between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed,....etc.)

YES (NO)

If yes, please explain and list the particular part cleaned: _____

7. Did you observe any residue on the part after using this solvent?

YES (NO)

8. Did you smell any odor?

(YES) NO

If yes, explain what type of odor and the degree of odor. (e.g. (strong,) mild, odorless, ...etc.)

Kerosene

9. Did you see any possible flammability problems with using this solvent?

(YES) NO

10. Rate this solvent's acceptability for cleaning your part?

5 Highly acceptable ..... (4) ..... 3 Acceptable ..... 2 ..... 1 Reject

REMARKS: Needs stronger + better support

Electron 296

SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS

TANK ID: ST-009

Date: 24 June 96

Name: SPC Wagner

Type of Part Cleaned (e.g. wheel bearings): Oil Drain Buckets 2 ea.

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

5 4 (3) 2 1

Heavily soiled.....moderately soiled.....lightly soiled

2. What type of media did you remove from the part? (Circle all that apply)

Grease (Oil) Dirt Mud Other (Describe) _____

3. Please rate the solvency (cleaning characteristics) of this solvent?

5 (4) 3 2 1

excellent.....good.....average.....poor

Remarks (If any): Took Oil off Quickly

4. What is your rating as to its drying time or how quickly did it evaporate?

5 (4) 3 2 1

fast.....normal.....slow

5. Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent?

YES (NO)

If yes, please explain what kind (e.g. pitting, rust, etc.): _____

6. Did you observe any incompatibility problems between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed,...etc.)

YES (NO)

If yes, please explain and list the particular part cleaned: _____

7. Did you observe any residue on the part after using this solvent?

YES (NO)

8. Did you smell any odor?

(YES) NO

If yes, explain what type of odor and the degree of odor. (e.g., strong, mild, odorless, ...etc.)

Nice Citrus Odor

9. Did you see any possible flammability problems with using this solvent?

YES (NO)

10. Rate this solvent's acceptability for cleaning your part?

(5) 4 3 2 1

Highly acceptable.....Acceptable.....Reject

REMARKS:

PF

SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS

TANK ID: ST-014

Date: 22 Aug 96

Name: Smith Ralph A

Type of Part Cleaned (e.g. wheel bearings): Air Dryer

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

5 4 3 2 (1)
Heavily soiled.....moderately soiled.....lightly soiled

2. What type of media did you remove from the part? (Circle all that apply)

Grease Oil Dirt (Mud) Other (Describe)_____

3. Please rate the solvency (cleaning characteristics) of this solvent?

(5) 4 3 2 1
excellent.....good.....average.....poor

REMARKS (If any):

4. What is your rating as to its drying time or how quickly did it evaporate?

5 4 (3) 2 1
fast.....normal.....slow

5. Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent? (e.g., pitting, rust, ...etc.)

YES (NO)

6. Did you observe any incompatibility problems between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed,....etc.)

YES (NO)

7. Did you observe any residue on the part after using this solvent?

YES (NO)

8. Did you smell any odor?

(YES) NO

if yes, explain what type of odor and the degree of odor. (e.g., strong, mild, odorless, ...etc.)

Citrus Smell

9. Did you see any possible flammability problems with using this solvent?

YES (NO)

10. Rate this solvent's acceptability for cleaning your part?

(5) 4 3 2 1
Highly acceptable.....Acceptable.....Reject

Skysol 100

SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS

Date: 22 July 96 TANK ID: ST-001

Name: Hawkins David C

Type of Part Cleaned (e.g. wheel bearings): Starter Motor

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

5 4 3 2 (1)

Heavily soiled.....moderately soiled.....lightly soiled

2. What type of media did you remove from the part? (Circle all that apply)

Grease (Oil) (Dirt) Mud Other (Describe) _____

3. Please rate the solvency (cleaning characteristics) of this solvent?

5 (4) 3 2 1

excellent.....good.....average.....poor

Remarks (If any): _____

4. What is your rating as to its drying time or how quickly did it evaporate?

5 4 (3) 2 1

fast.....normal.....slow

5. Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent?

YES (NO)

If yes, please explain what kind (e.g. pitting, rust, etc.): _____

6. Did you observe any incompatibility problems between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed,....etc.)

YES (NO)

If yes, please explain and list the particular part cleaned: _____

7. Did you observe any residue on the part after using this solvent?

YES (NO)

8. Did you smell any odor?

(YES) NO

If yes, explain what type of odor and the degree of odor. (e.g., strong, mild, odorless, ...etc.)

Citrus

9. Did you see any possible flammability problems with using this solvent?

YES (NO)

10. Rate this solvent's acceptability for cleaning your part?

5 (4) 3 2 1

Highly acceptable.....Acceptable.....Reject

REMARKS:

Unocal 150

HUMAN FACTOR SURVEY

PREVIOUS 7/11/96

1. What class of material is cleaned by P-D-680 solvents? (e.g., artillery, armored, tactical vehicles, combat service suppoort, aircrafts, etc...) ARTILLERY

2. What is your organization / installation? SERVICE BTRY

3. Provide your name, title, address and phone number. MARIANO DELAO PV2

4. What types of P-D-680 solvents are you currently using to clean vehicles or other equipment? (e.g. , types I,II,III) TOWEL CLEAN (HAND)

5. Are you currently using other than P-D-680 solvents? NO

6. What problems have you experienced with current P-D-680 solvents?

7. What do you like about current P-D-680 solvents?

8. What don't you like about current P-D-680 solvents?

9. What type of P-D-680 solvents do you like that fit your applications?

~~NEW~~ NEW SOLVENT

10. Name of solvent? UNOCAL

11. Did you receive training on how to use the partswasher? (yes) no

12. What type of cleaning method(s) did you use to evaluate this solvent? PW VS HAND

13. What types of equipment or parts were used to evaluate this solvent? (what did you clean in the parts washer? i.e., wheel bearings....) TURRET PART

14. What is your opinion on the solvency of this solvent? (i.e., cleaning characteristics, excellent, good, average, poor)

excellent

15. What is your rating as to its drying time or how quickly did it evaporate? (e.g., fast, normal, slow)

slow

16. Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent? (e.g., pitting, rust, ...etc.)

NO

17. Did you observe any incompatibility problem between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed, ... etc.)

NO.

18. Did you smell any odor? If so, describe what type of odor and the degree of odor. (e.g. strong, mild, odorless, ... etc.)

STRONG ODOR, SOLVENT SMELL

19. When comparing this solvent with P-D-680, which product is better fitted for your applications?

N/A

20. Overall, what rating would you give for this solvent? (accept / reject)

21. Have you, or did you have knowledge of others that may have experienced nausea, skin rashes, or other adverse effects from use of this alternative P-D-680 solvent? Discuss.

NO

22. Did you see any possible flammability problems with using this solvent?

NO.

23. SPEAK OUT! Please discuss anything else pertaining to the testedsolvent that you would like to voice, especially comments and suggestions for the development of an improved cleaning product?

If it smells better, it washed grime right off. (citrus)

b. Weapon Cleaning Application

- Skysol 100
- Skysol
- Breakthrough

Skysol 100

SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS

Date: 19 JUNE 96 TANK ID: ST-013

Name: DARBY

Type of Part Cleaned (e.g. wheel bearings): CH47D ENG

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

5 4 (3) 2 1

Heavily soiled.....moderately soiled.....lightly soiled

2. What type of media did you remove from the part? (Circle all that apply)

(Grease) Oil (Dirt) Mud Other (Describe) _____

3. Please rate the solvency (cleaning characteristics) of this solvent?

5 (4) 3 2 1

excellent.....good.....average.....poor

Remarks (If any): _____

4. What is your rating as to its drying time or how quickly did it evaporate?

5 4 3 (2) 1

fast.....normal.....slow

5. Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent?

YES (NO)

If yes, please explain what kind (e.g. pitting, rust, etc.): _____

6. Did you observe any incompatibility problems between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed,....etc.)

YES (NO)

If yes, please explain and list the particular part cleaned: _____

7. Did you observe any residue on the part after using this solvent?

YES (NO)

8. Did you smell any odor?

(YES) NO

If yes, explain what type of odor and the degree of odor. (e.g., strong, mild, odorless, ...etc.)

(ORANGE)

9. Did you see any possible flammability problems with using this solvent?

YES (NO)

10. Rate this solvent's acceptability for cleaning your part?

5 (4) 3 2 1

Highly acceptable.....Acceptable.....Reject

REMARKS:

Skysol

R.O.T.C. SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS

TANK ID: WC-001-002

Date: 25JUL96

Name: HALL, ZACHARY X

Type of WEAPON CLEANED M-16 A-1

1. What Type of Ammunition was used 5.56 Blank

2. How many rounds fired 200

3. Please rate the solvency (cleaning characteristics) of this solvent?

5 excellent ..... 4 good ..... 3 average ..... 2 ..... 1 poor

REMARKS (If any):

4. What is your rating as to its drying time or how quickly did it evaporate?

5 fast ..... 4 ..... 3 normal ..... 2 ..... 1 slow

5. Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent? (e.g., pitting, rust, ...etc.) YES NO

6. Did you observe any incompatibility problems between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed,....etc.) YES NO

7. Did you observe any residue on the part after using this solvent? YES NO

8. Did you smell any odor? YES NO

if yes, explain what type of odor and the degree of odor. (e.g., strong, mild, odorless, ...etc.)

mild citrus smell

9. Did you see any possible flammability problems with using this solvent? YES NO

10. Rate this solvent's acceptability for cleaning your part?

5 Highly acceptable ..... 4 ..... 3 Acceptable ..... 2 ..... 1 Reject

11. How long did it take you to clean your weapon ? 4 min

12. How long did it previously take you to clean your weapon ? 2-3 hrs

13. What did you previously use to clean your weapon? Break Free

REMARKS:

Breakthrough

R.O.T.C. SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS

TANK ID: WC-001WC002

Date: 8/6/70

Name: Keith Allen

Type of WEAPON CLEANED M-16

1. What Type of Ammunition was used Blanks

2. How many rounds fired 200

3. Please rate the solvency (cleaning characteristics) of this solvent?

5 (4) 3 2 1

excellent.....good.....average.....poor

REMARKS (If any):

4. What is your rating as to its drying time or how quickly did it evaporate?

5 (4) 3 2 1

fast.....normal.....slow

5. Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent? (e.g., pitting, rust, ...etc.) YES (NO)

6. Did you observe any incompatibility problems between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed,....etc.) YES (NO)

7. Did you observe any residue on the part after using this solvent? YES (NO)

8. Did you smell any odor? YES (NO)

if yes, explain what type of odor and the degree of odor. (e.g., strong, mild, odorless, ...etc.)

9. Did you see any possible flammability problems with using this solvent? YES (NO)

10. Rate this solvent's acceptability for cleaning your part?

(5) 4 3 2 1

Highly acceptable.....Acceptable.....Reject

11. How long did it take you to clean your weapon ? 30 min

12. How long did it previously take you to clean your weapon ? 1 hr

13. What did you previously use to clean your weapon? CP

REMARKS:

c. Aviation Application

- Skysol 100

Skysol 100

SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS

TANK ID: ST-013

Date: 15 Aug 96
Name: D SCHRABACK

Type of Part Cleaned (e.g. wheel bearings): ROTOR PVH CAPS

Circle the number or answer that best describes your response.

1. What was the condition of the part or parts you cleaned? (Circle the number that best describes your response)

5 4 3 2 (1)
Heavily soiled.....moderately soiled.....lightly soiled

2. What type of media did you remove from the part? (Circle all that apply)

Grease (Oil) Dirt Mud Other (Describe) _____

3. Please rate the solvency (cleaning characteristics) of this solvent?

5 4 (3) 2 1
excellent.....good.....average.....poor

Remarks (If any): _____

4. What is your rating as to its drying time or how quickly did it evaporate?

5 4 3 2 (1)
fast.....normal.....slow

5. Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent?

YES (NO)

If yes, please explain what kind (e.g. pitting, rust, etc.):_____

6. Did you observe any incompatibility problems between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed,....etc.)

YES (NO)

If yes, please explain and list the particular part cleaned:_____

7. Did you observe any residue on the part after using this solvent?

YES (NO)

8. Did you smell any odor?

(YES) NO

If yes, explain what type of odor and the degree of odor. (e.g., strong, mild, odorless, ...etc.)

CITRUS

9. Did you see any possible flammability problems with using this solvent?

YES (NO)

10. Rate this solvent's acceptability for cleaning your part?

5 4 (3) 2 1
Highly acceptable.....Acceptable.....Reject

REMARKS:

Appendix C-2. Typical Data obtained from Fort Hood

- Skysol 100
- Breakthrough

FINAL RESULTS OF SOLVENT EVALUATION
(FORT HOOD, TX)

INPUT DATES: 1 June 1996 - 30 August 1996

SITES: FHT1: Helicopter Engine Repair Shop, Bldg 6970

FHT2: Helicopter Propeller Rotor Repair Shop, Bldg 7012

FHT3: Helicopter Weapons Maintenance Shop, Bldg 6975

FHT4: Helicopter Generator Repair Shop, Bldg 739

1. USER CATEGORY: What class of material is cleaned by PD-680 solvents?

FHT1: Aircraft Engine Parts
FHT2: Aircraft parts / bearings / rotor shafts
FHT3: Personal crew weapons, and on-board system weapons for AH-64, AH-1F, and OH-58D helicopters
FHT4: Aircraft starters, starter generators, and generators

What is your organization and installation?

All stations are operated by DYNCORP service personnel under contract to the Fort Hood Directorate of Logistics (DOL), Aviation Maintenance Branch

Please provide name, title, address, and phone number:

FHT1:	Glenn Magnusson, Engine Mechanic	#817-287-3252
FHT2:	Billy Stinson, Prop and Rotor Repairman	#817-287-2539
FHT3:	Jeffrey Baynes, Working Leadman	#817-288-3510
FHT4:	Chuck Crowder, Electrician	#817-288-3560

2. EVALUATION OF CURRENT PD-680 SOLVENTS:

What types of PD-680 solvents are you currently using to clean weapons, vehicles, or other equipment?

FHT1: Type II
FHT2: Type II
FHT3: Type II
FHT4: Type II

Are you currently using other than PD-680 type solvents?

FHT1: No
FHT2: No
FHT3: No
FHT4: Yes, Ecolink

What problems have you experienced with current PD-680 solvents?

FHT1: None
FHT2: It stinks
FHT3: It smells bad, nauseating
FHT4: None

What do you like about current PD-680 solvents?

FHT1: Good cleaning characteristics
FHT2: Evaporates quickly
FHT3: It cleans OK
FHT4: It cleans most things OK

What don't you like about current PD-680 solvents?

FHT1: the odor
FHT2: the fumes cause nausea
FHT3: smells bad
FHT4: it doesn't clean burned on grease very well

What type of PD-680 solvents do you like that fit your application?

FHT1: PD-680 Type II
FHT2: PD-680 Type II works well, but SKYSOL 100 works better
FHT3: none
FHT4: no comment

3. EVALUATING ALTERNATIVE SOLVENTS:

Name of Solvent:

FHT1: BreakThrough
FHT2: Skysol 100
FHT3: Skysol 100
FHT4: BreakThrough

What type of cleaning method did you use to evaluate this solvent?

FHT1: Solvent Tank
FHT2: Brushes and soaking
FHT3: Solvent Tank, soaking and brushes
FHT4: Wet brush rinse

What types of equipment or parts were used to evaluate this solvent?

FHT1: Helicopter engine parts
FHT2: Helicopter parts, bearings, rotors, etc.
FHT3: Personal weapons and helicopter weapon systems
FHT4: Helicopter starters and generators

What is your opinion of the solvency?

FHT1: excellent
FHT2: excellent
FHT3: excellent
FHT4: excellent

What is your rating as to its drying time or how quickly it evaporates?

FHT1: normal
FHT2: too slow
FHT3: normal
FHT4: normal

Did you observe any corrosion forming on surfaces of the cleaned parts due to the solvent?

FHT1: No
FHT2: No
FHT3: No
FHT4: No

Did you observe any compatibility problems between this solvent and parts?

FHT1: No
FHT2: No
FHT3: No
FHT4: No

Did you smell any odor? If so, describe the type and degree:

FHT1: odorless
FHT2: yes, orange odor - pleasant
FHT3: yes, nice orange smell
FHT4: no

When comparing this solvent to PD-680, which product is better fitted for your application?

FHT1: either one
FHT2: Skysol 100
FHT3: Skysol 100
FHT4: BreakThrough

Overall, what rating would you give for this solvent?

FHT1: accept
FHT2: accept
FHT3: accept
FHT4: accept

4. HEALTH AND SAFETY OF ALTERNATIVE PD-680 SOLVENT:

Have you, or did you have knowledge of others that may have experienced nausea, skin rashes, or other adverse affects from use of this alternative PD-680 solvent?

FHT1: dries skin
FHT2: no
FHT3: dries hands
FHT4: none

Did you have problems in disposing of this alternative PD-680 solvent that you tested?

FHT1: Haven't disposed of
FHT2: Haven't disposed of
FHT3: Haven't disposed of
FHT4: Haven't disposed of

Did you see any possible flammability problems with using this solvent?

FHT1: No
FHT2: No
FHT3: No
FHT4: No

5. SPEAK OUT: Please discuss anything else pertaining to tested solvent that you would like to voice, especially comments and suggestions for the development of an improved cleaning product:

FHT1: It is an acceptable substitute for PD-680, and we like it better

FHT2: We've changed filters twice, and added solvent once to top off the tank. The solvent is dark and dirty looking, but comes out of the brushes clear. It works just as well as when it was new, so the filter must be working.

FHT3: The station is great -- it's big enough to put an entire 50 caliber machine gun in for cleaning, and it cleans great. We would like to see a handle on the lid, and maybe a trip-latch that would allow lowering the lid from either side.

FHT4: The solvent works good, but the best part is the station with the filter. This stuff even cleans off the burned on grease.

INSTALLATION POC COMMENTS:

1. The propeller shop gets the most use out of their station. To date, they are the only ones who have changed filters (twice), and have needed to add solvent to fill up the tank.

2. Most comments were on the washer stations -- even though everyone liked the solvents, they love the stations. So much so, that the DOL took it upon themselves to order two additional stations to replace the remaining two old SAFETY-CLEAN stations. So, now they are completely equipped with the new INLAND stations and solvents at the Aviation Maintenance Branch.

3. The note above show the level of dissatisfaction with the SAFETY-CLEAN service. They feel they can do much better on their own, with their new stations, and with the filtration system that they feel will extend the life of their new solvents.

4. In my opinion, this was a completely successful evaluation and proves the usefulness of the new alternative solvents. Even more so, I think it shows that filtration technology can significantly reduce the solvent waste stream. Therefore, I intend to propose a P2 project that will completely convert all of Fort Hood to the new stations over then next few years. Alternative solvents approved by TARDEC will be utilized in the new stations, and the information and project plans will be shared with other installations. Fort Polk has already done an analysis that shows they can save about $100k per year by converting to the new stations and solvents.

R.J. HOLLEY
Science & Technology Advisor
III Corps and Fort Hood

Appendix C-3. Typical Data obtained from Kelly AFB

- Breakthrough
- Actrel 1171L
- Electron 296

Richard T. Escobedo

Breakthrough

SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS

1. USER CATEGORY

What class of materiel is cleaned by P-D-680 solvents? (e.g., weapons, artillery, armored, tactical vehicles, combat service support, aircrafts, ships, bearings, etc...)

Aircraft Parts

What is your organization and installation?

Unified Fuel Control Section
LD PPB

Please provide your name, title, address and phone number:

RICHARD T. ESCOBEDO
Fuel Systems Mechanic
925-7554

Kelly Air Force Base
San Antonio, Texas
78241

2. EVALUATION OF CURRENT P-D-680 SOLVENTS

What types of P-D-680 solvents are you currently using to clean weapons, vehicles, or other equipment? (e.g., types 1, 2, or 3)

Type II

Are you currently using other than P-D-680 solvents?

Yes

What problems have you experienced with current P-D-680 solvents?

None

What do you like about current P-D-680 solvents?

Does the job, Less fumes...

Attachment

What don't you like about current P-D-680 solvents?

What type of P-D-680 solvents do you like that fit your applications?

Use to get dirty in a hurry.

3. EVALUATING ALTERNATIVE P-D-680 SOLVENTS

Name of solvent:

Break-through.

What type of cleaning method(s) did you use to evaluate this solvent? (short description)

Paint Brush and wire brush

What types of equipment or parts were used to evaluate this solvent?

Table top vat.

What is your opinion on the solvency (i.e., cleaning characteristics) of this solvent? (e.g., excellent, good, average, poor)

Excellent. 15

What is your rating as to its drying time or how quickly did it evaporate? (e.g.,fast, normal, slow)?

Normal 3

Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent? (e.g., pitting, rust,...etc.)

No.

Did you observe any in compatibility problem between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed,... etc.)

No visible problems.

Did you smell any odor? If so, describe what type of odor and the degree of odor. (e.g., strong, mild, odorless, ...etc.)

None. 25

When compared this solvent with P-D-680, which product is better fitted for your applications?

Break-through

Overall, what rating would you give for this solvent? (accept, or reject)

Accept.

4. **HEALTH, SAFETY OF ALTERNATIVE P-D-680 SOLVENT**

Have you, or did you have knowledge of others that may have experienced nausea, skin rashes, or other adverse effects from use of this alternative P-D-680 solvent? Discuss.

No.

Did you have problems in disposing of this alternative P-D-680 solvent that you tested?

No problems.

Did you see any possible flammability problems with using this solvent?

None

5. **SPEAK OUT!**

Please discuss anything else pertaining to tested solvent that you would like to voice, especially comments and suggestions for the development of an improved cleaning product?

Suggestions for improved cleaning would be a solvent where no brushing would be necessary. Just drop it in and after a few minutes take it out clean.

6. **This solvent evaluation sheet should be returned as soon as possible after completion of field test:**

DEPARTMENT OF THE ARMY
MOBILITY TECHNOLOGY CENTER - BELVOIR
ATTN AMSTA RBF (MR I RHEE)
10115 Gridely Rd STE 128
FORT BELVOIR, VA 22060-5843

Questions may be directed to:

Mr. In-Sik Rhee Fuels and Lubricants Technology Team
Telephone: (703) 704-1824 or DSN 654-1824
Fax: (703) 704-1822

Actrel 1171L

SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS

1. USER CATEGORY

What class of materiel is cleaned by P-D-680 solvents? (e.g., weapons, artillery, armored, tactical vehicles, combat service support, aircrafts, ships, bearings, etc...)

AIRCRAFTS

What is your organization and installation?

UFC Section
LDPPB

Please provide your name, title, address and phone number:

Richard DeLeon WG10-8255
1310 348, Kelly AFB, S. ATexas
925 7554

2. EVALUATION OF CURRENT P-D-680 SOLVENTS

What types of P-D-680 solvents are you currently using to clean weapons, vehicles, or other equipment? (e.g., types 1, 2, or 3)

TYPE 2

Are you currently using other than P-D-680 solvents?

Yes

What problems have you experienced with current P-D-680 solvents?

NONE

What do you like about current P-D-680 solvents?

Does the good JOB

Attachment

What don't you like about current P-D-680 solvents?

We Do Like it.

What type of P-D-680 solvents do you like that fit your applications?

~~ACTREL 111L Cleaner~~

None on Hand

3. EVALUATING ALTERNATIVE P-D-680 SOLVENTS

Name of solvent:

ACTREL 111L Cleaner

What type of cleaning method(s) did you use to evaluate this solvent? (short description)

Table Top VAT.

What types of equipment or parts were used to evaluate this solvent?

AIRCRAFT Parts

What is your opinion on the solvency (i.e., cleaning characteristics) of this solvent? (e.g., excellent, good, average, poor) I do not like the oil in the solvent or the smell 3

What is your rating as to its drying time or how quickly did it evaporate? (e.g.,fast, normal, slow)?

Slow 2

Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent? (e.g., pitting, rust,...etc.)

None

Did you observe any in compatibility problem between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed,... etc.)

NO

Did you smell any odor? If so, describe what type of odor and the degree of odor. (e.g., strong, mild, odorless, ...etc.)

5

Yes, STRONG

When compared this solvent with P-D-680, which product is better fitted for your applications?

P-D-680

Overall, what rating would you give for this solvent? (accept, or reject)

Reject.

4. HEALTH, SAFETY OF ALTERNATIVE P-D-680 SOLVENT

Have you, or did you have knowledge of others that may have experienced nausea, skin rashes, or other adverse effects from use of this alternative P-D-680 solvent? Discuss.

NO

Did you have problems in disposing of this alternative P-D-680 solvent that you tested?

STILL IN USE

Did you see any possible flammability problems with using this solvent?

NO

5. SPEAK OUT!

Please discuss anything else pertaining to tested solvent that you would like to voice, especially comments and suggestions for the development of an improved cleaning product?

Would not use unless nothing else was around.

6. This solvent evaluation sheet should be returned as soon as possible after completion of field test:

DEPARTMENT OF THE ARMY
MOBILITY TECHNOLOGY CENTER - BELVOIR
ATTN AMSTA RBF (MR I RHEE)
10115 Gridely Rd STE 128
FORT BELVOIR, VA 22060-5843

Questions may be directed to:

Mr. In-Sik Rhee Fuels and Lubricants Technology Team
Telephone: (703) 704-1824 or DSN 654-1824
Fax: (703) 704-1822

SOLVENT EVALUATION SHEET FOR P-D-680 REPLACEMENTS

1. USER CATEGORY

What class of materiel is cleaned by P-D-680 solvents? (e.g., weapons, artillery, armored, tactical vehicles, combat service support, aircrafts, ships, bearings, etc...)

AEROSPACE GROUND EQUIPMENT

What is your organization and installation?

433 MXS/AGE LGMF

KELLY AFB

Please provide your name, title, address and phone number:

Steven Fazzini, AGE Mechanic, USAFR @ duty phone (210) 977-4098

1305 W. VILLA MARIA, APT E103

Bryan, Tx 77801

2. EVALUATION OF CURRENT P-D-680 SOLVENTS

What types of P-D-680 solvents are you currently using to clean weapons, vehicles, or other equipment? (e.g., types 1, 2, or 3)

Not sure

Are you currently using other than P-D-680 solvents?

Citri-kleen

What problems have you experienced with current P-D-680 solvents?

None

What do you like about current P-D-680 solvents?

leave little or no film after cleaning

completely removes wet and sticky oil

works @ pretty well on dry hard oil

What don't you like about current P-D-680 solvents?

What type of P-D-680 solvents do you like that fit your applications?

3. EVALUATING ALTERNATIVE P-D-680 SOLVENTS

Name of solvent: Electron 296

What type of cleaning method(s) did you use to evaluate this solvent? (short description)

used recirculating type parts washer, for additional effectiveness used a soft parts cleaning brush, soaked some parts

What types of equipment or parts were used to evaluate this solvent?

wheel bearings and ~~her~~ related hardware

starter

What is your opinion on the solvency (i.e., cleaning characteristics) of this solvent? (e.g., excellent, good, average, poor)

excellent

What is your rating as to its drying time or how quickly did it evaporate? (e.g., fast, normal, slow)?

very good evaporation rate, No noticeable evaporation, but parts dried quickly i.e. did not dry out while trying to clean

Did you observe any corrosion forming on the surface of the cleaned parts due to the solvent? (e.g., pitting, rust,...etc.)

No undesirable surface effects noted

Did you observe any in compatibility problem between this solvent and parts? (e.g., softened plastic material, elastomer shrinking or swelling, coating being removed,... etc.)

No, but did not allow soft parts to soak, wipe down resulted in no noted undesirable effects

Did you smell any odor? If so, describe what type of odor and the degree of odor. (e.g., strong, mild, odorless, ...etc.)

very pleasant

When compared this solvent with P-D-680, which product is better fitted for your applications?

This product worked better than the old solvent we used but I am unsure what the previous product was.

Overall, what rating would you give for this solvent? (accept, or reject)

Accept

4. HEALTH, SAFETY OF ALTERNATIVE P-D-680 SOLVENT

Have you, or did you have knowledge of others that may have experienced nausea, skin rashes, or other adverse effects from use of this alternative P-D-680 solvent? Discuss.

No more than any previously used solvent. Less irritating than some solvents (cannot provide list) I have used in the past - both government and commercial

Did you have problems in disposing of this alternative P-D-680 solvent that you tested?

No, but I am not responsible for the actual disposal, only to ensure it is disposed in proper containers and delivered to hazardous waste disposal personnel

Did you see any possible flammability problems with using this solvent?

None noted

5. **SPEAK OUT!**

Please discuss anything else pertaining to tested solvent that you would like to voice, especially comments and suggestions for the development of an improved cleaning product?

Minor contact did not result in skin irritation. Washes well with soap and water. Compare this to diesel fuel, where ~~hand feel~~ skin feels unpleasant and retains odor after repeated washings. New solvent left little or no unpleasant odor or slickness after soap and water washing.

Product did not leave oily film or dry residue on parts after use.

Product did not evaporate too fast to use. Compare this to brake cleaner (such as 1-1-3 trichloroethane) which evaporates so fast as to make it impractical for heavy duty cleaning.

6. **This solvent evaluation sheet should be returned as soon as possible after completion of field test:**

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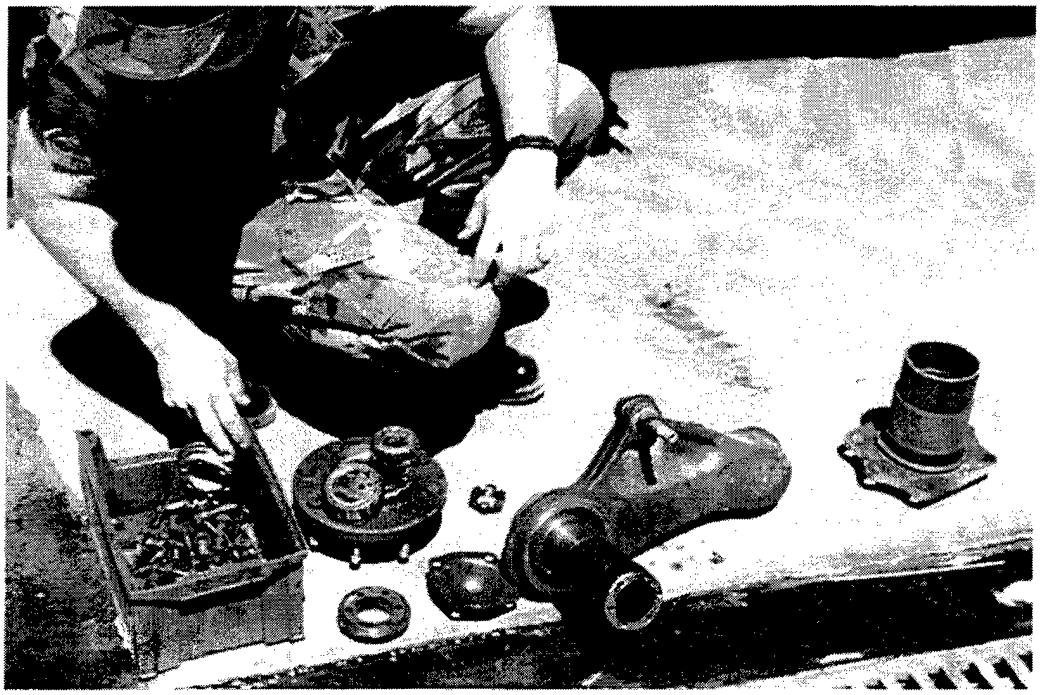
Questions may be directed to:

Mr. In-Sik Rhee Fuels and Lubricants Technology Team
Telephone: (703) 704-1824 or DSN 654-1824
Fax: (703) 704-1822

D. Photos taken from Field Demonstrations

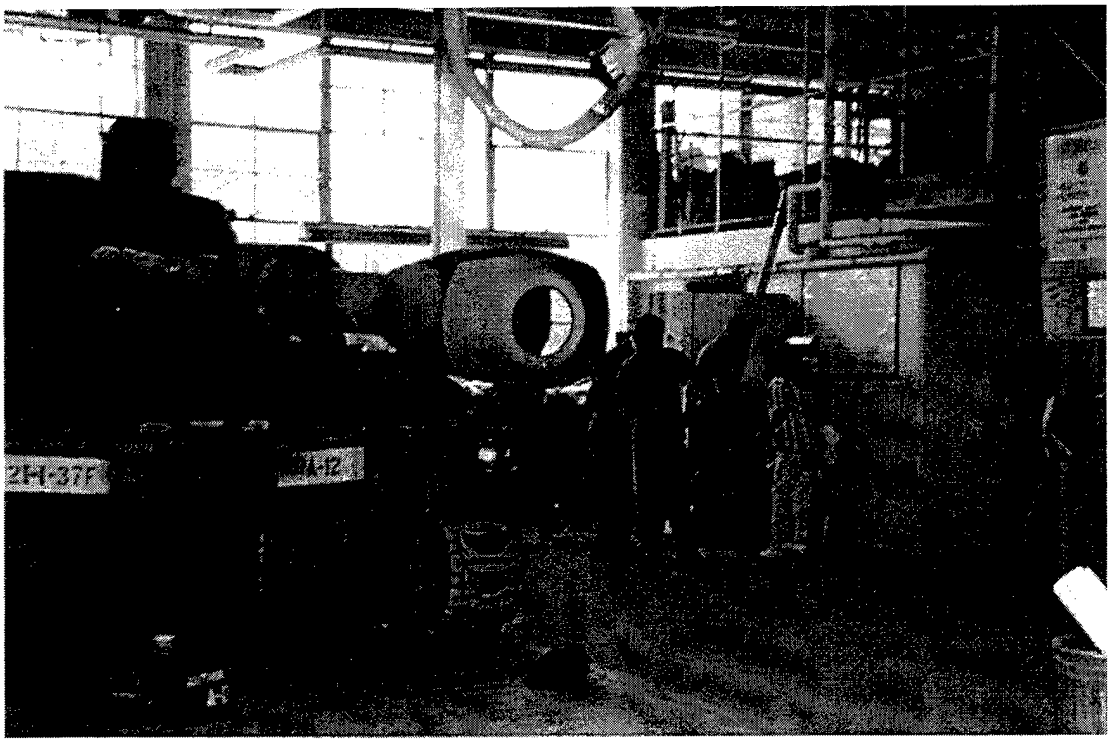
Solvent Demonstration at Fort Lewis

Vehicle Maintenance Shops



Parts Used in Solvent Demonstration

Vehicle Maintenance Shops

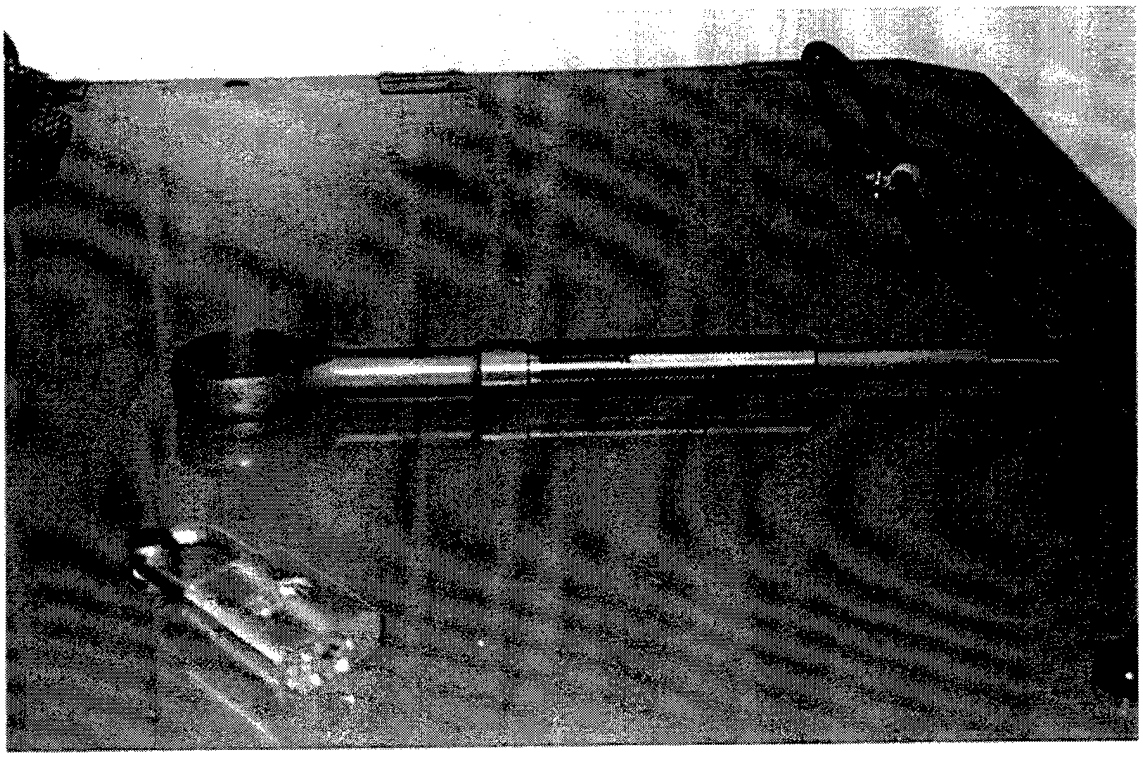


Corrosion Occured Due to the Water Based Solvent

Weapon Cleaning Applications

Weapon Cleaning Applications

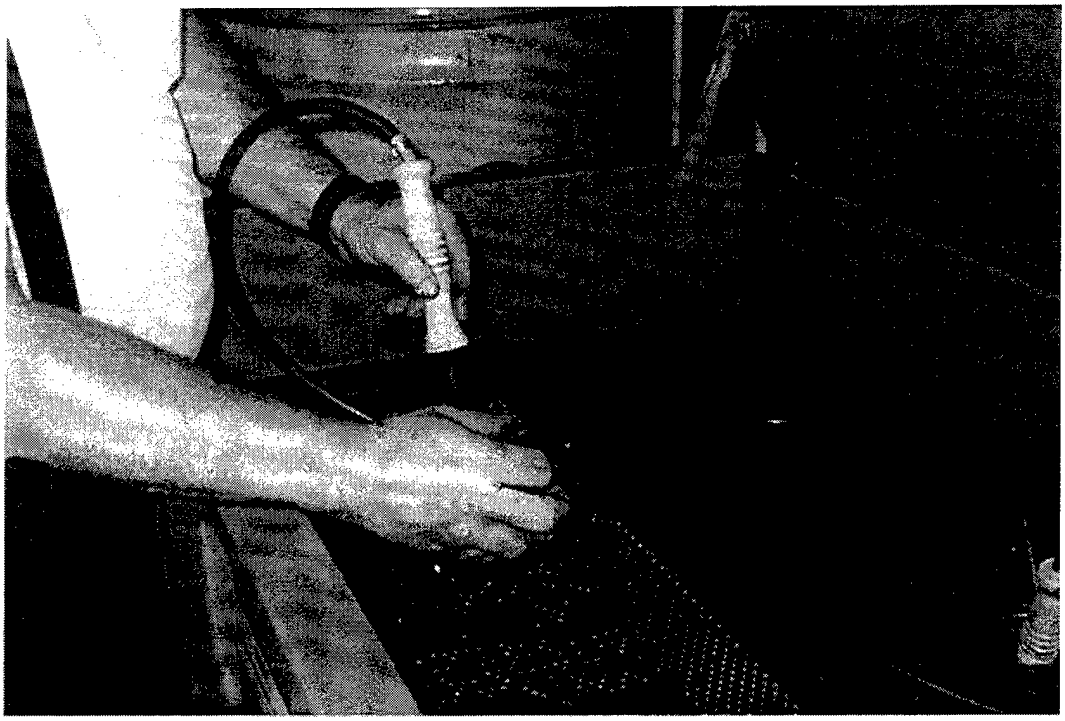
Aviation Maintenance Shops

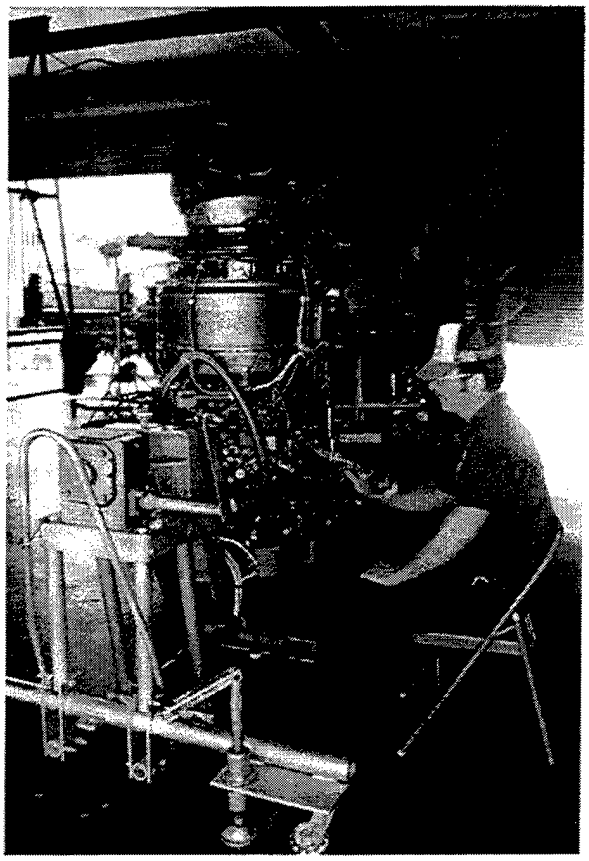


An Aviation Part Used in Solvent Demonstration

Solvent Demonstration at Fort Hood

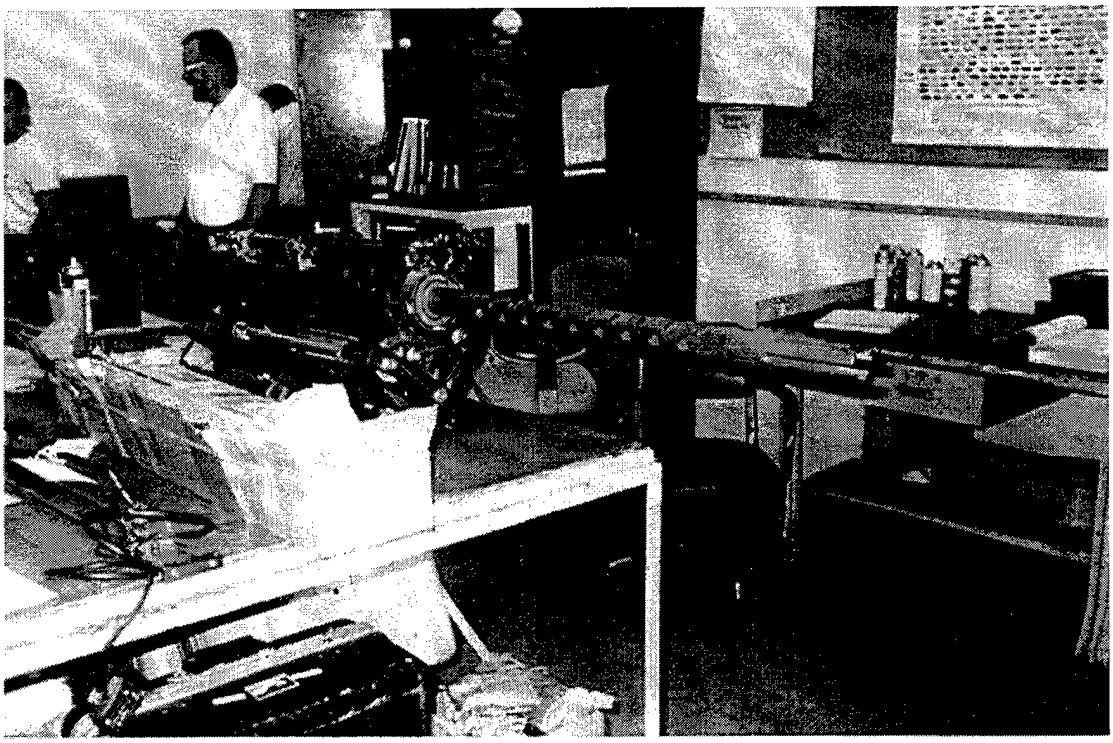
Helicopter Maintenance Shops



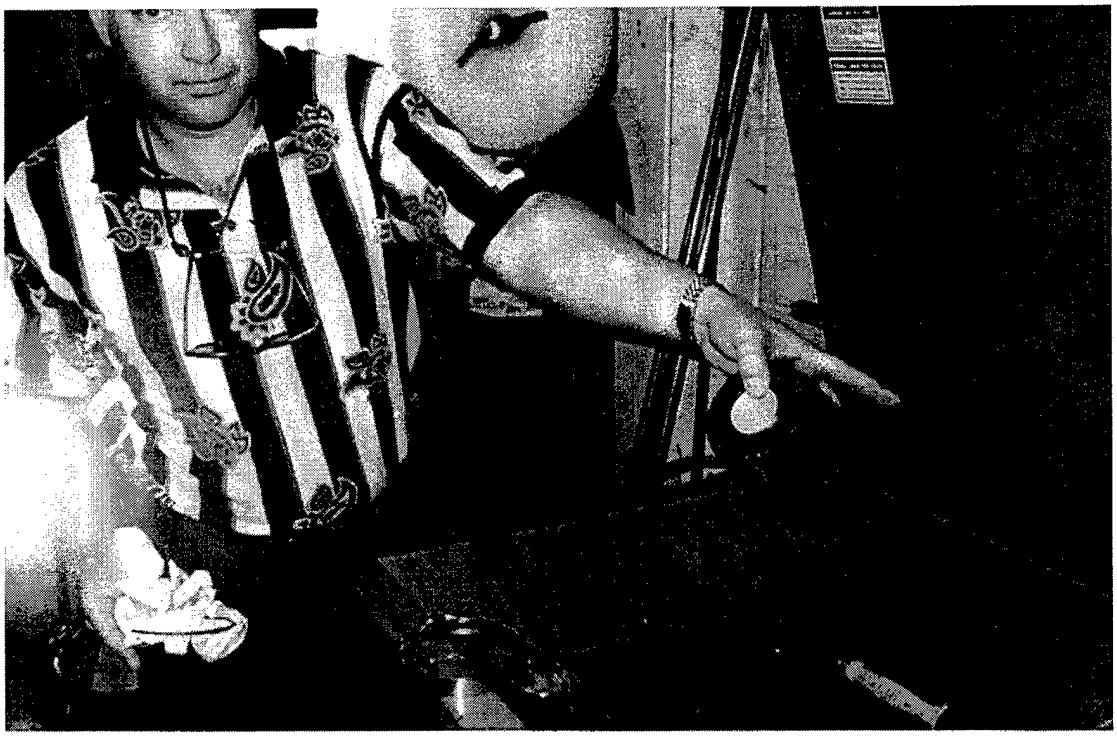


Helicopter Engine Being Cleaned

Helicopter Gun Maintenance Shop

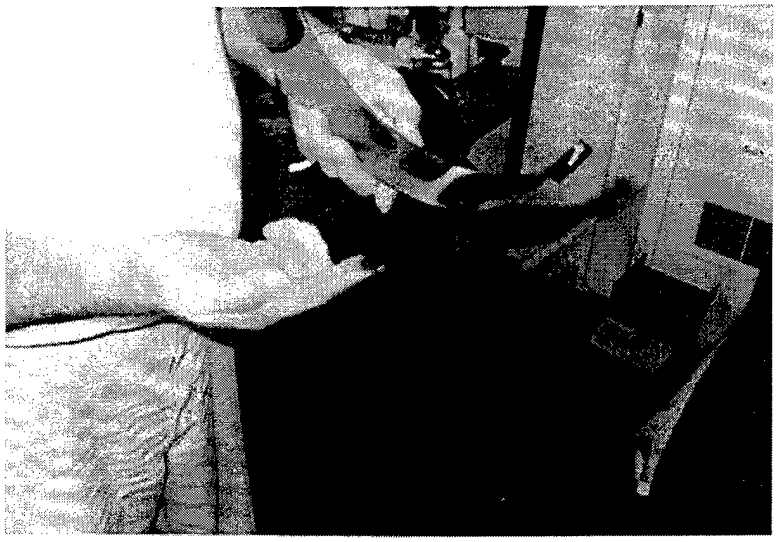


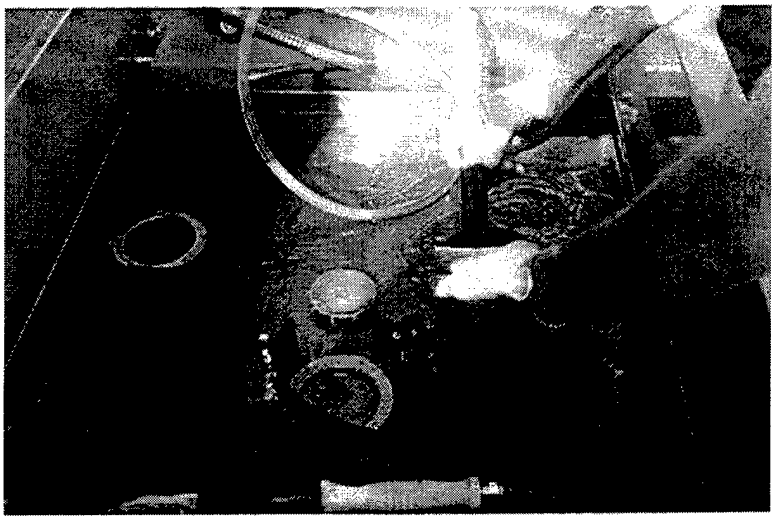
Helicopter Gun Used in Solvent Demonstration

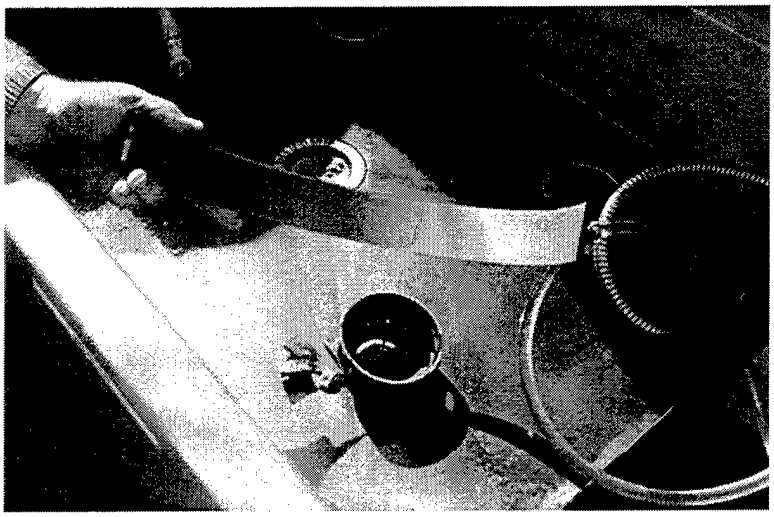


Used Filter Being Cleaned

Aviation Generator Repair Shops



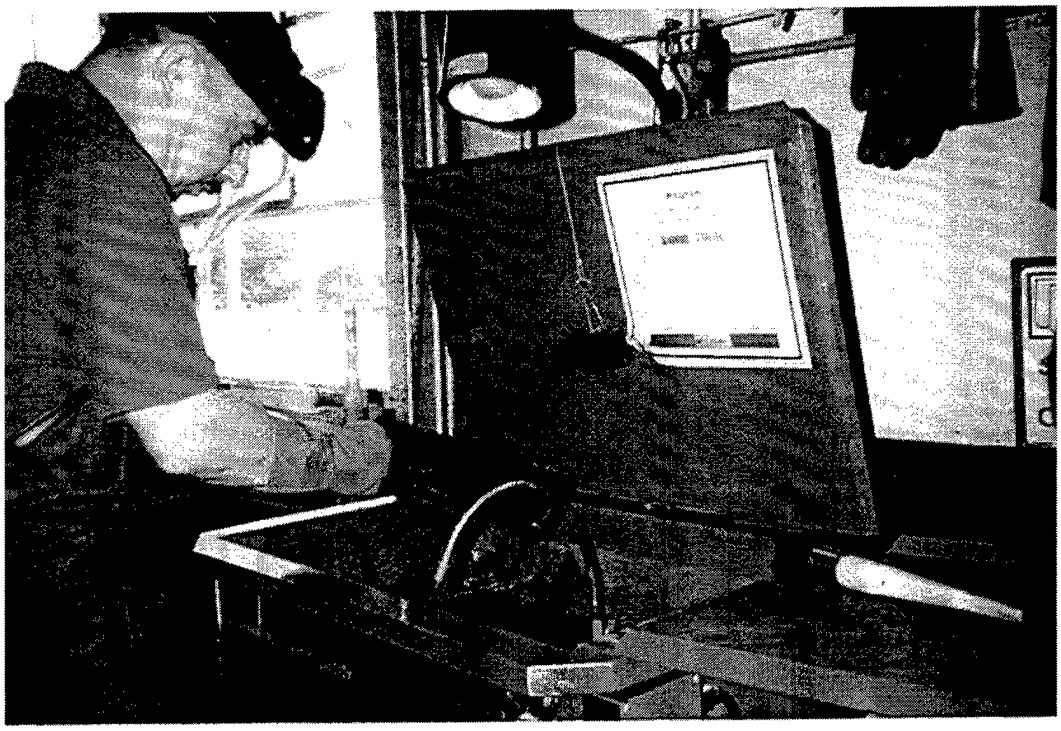




Demonstration of Cleaning Power, Dirty Part, Cleaning Part, Cleaned Part

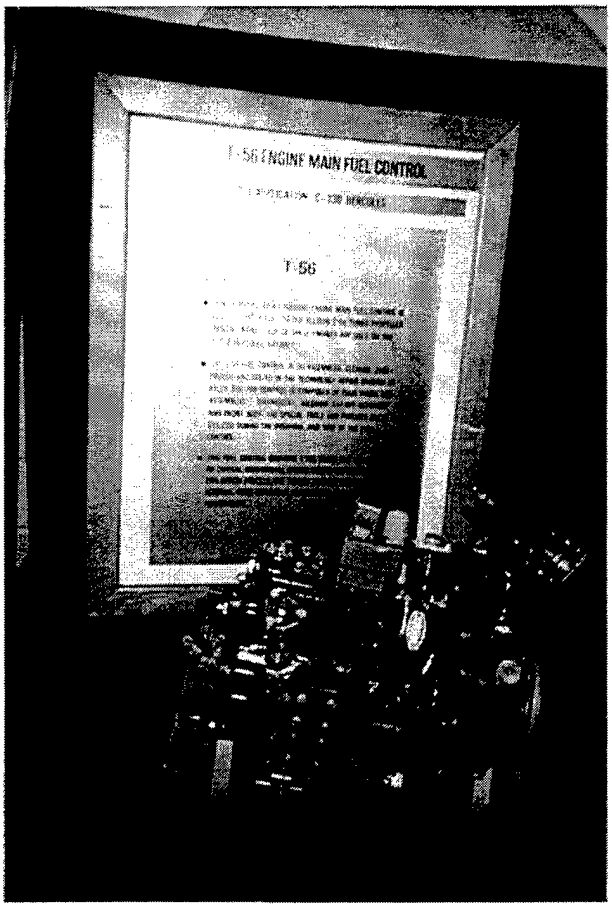
Solvent Demonstration at Kelly Air Force Base

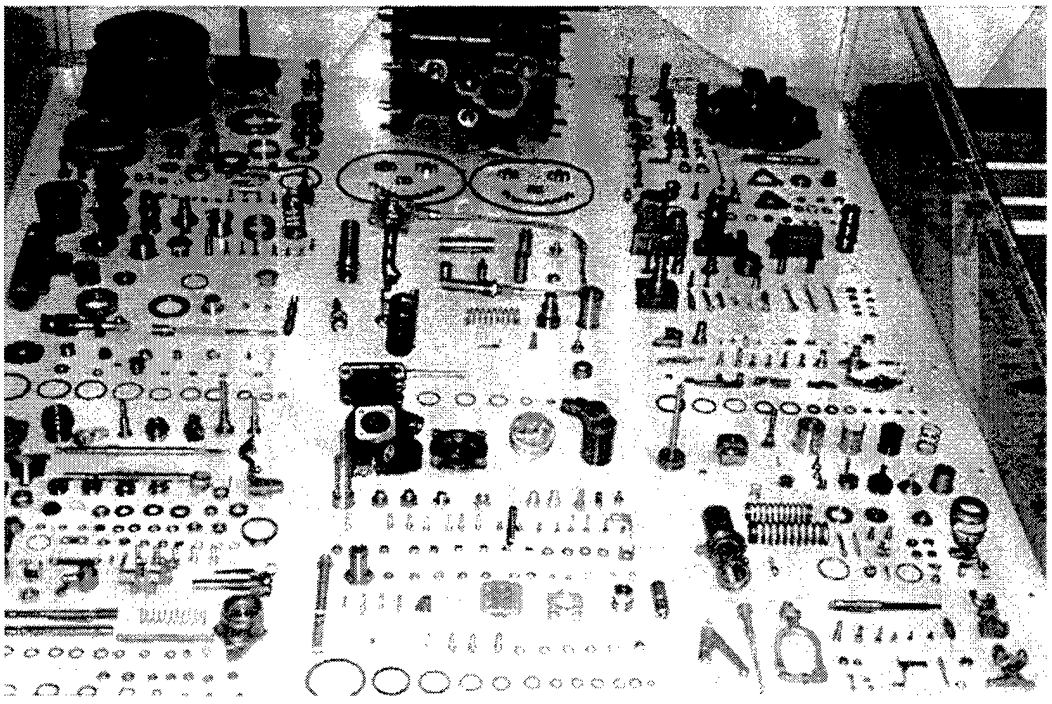
Aviation Ground Equipment Shop



Before (left) and After (right) Cleaning

Parts Used at the Aviation Fuel Control Equipment Repair Shop





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